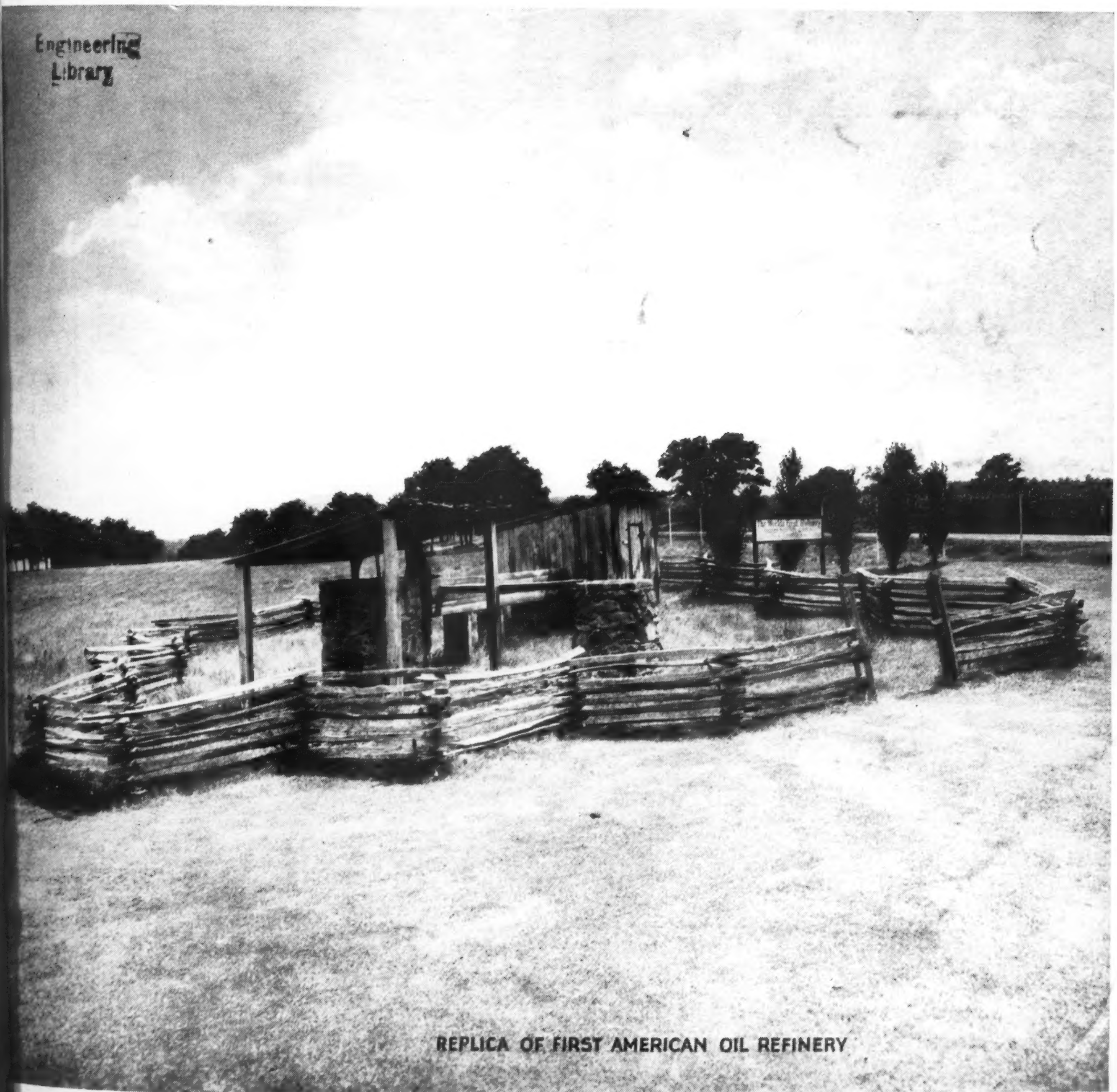
Compressed Air Magazine

VOLUME 47 · NUMBER 8 AUGUST 1942 LONDON · NEW YORK · PARIS



REPLICA OF FIRST AMERICAN OIL REFINERY

ON THE COVER

IN AUGUST, 1859, Col. E. L. Drake, a retired railroad conductor, struck "rock oil" at a depth of 69½ feet in western Pennsylvania. In the following year, William Barnsdall and W. H. Abbott built the nation's first petroleum refinery near Titusville, Pa. Up to that time, the only "refined" oil produced in the world came from plants erected in Scotland to distill the liquid contained in oil shales.

Compared with modern refineries, the Titusville plant was a puny and inefficient affair, but it answered the needs of its day. Kerosene was the principal product in demand, and the gasoline usually had to be burned or disposed of in some other manner because there was no market for it. A batch of crude oil was charged into the still and heat applied. The vapors that came off were condensed by mixing them with cold water from a nearby spring.

The capacity of the plant is not known, but reports handed down from old-timers indicate that 50-gallon wooden barrels were used in the receiving house to catch the kerosene condensate. As the kerosene content of paraffin-base crude oil averages around 5 per cent, it is probable that from 1,000 to 1,500 barrels of petroleum were required to produce a barrel of kerosene. It is believed the heavier oil remaining in the still after the lighter fractions had been driven off was used for operating fuel. After a batch of crude oil had been treated, the still had to be emptied and refilled.

In 1924 the Barnsdall Oil Refining Company built the replica of the apparatus that is pictured on our cover and displayed it at the International Petroleum Exposition in Tulsa, Okla. It was afterward set up in front of the office of one of the company's refineries at Barnsdall, Okla., where it still stands. Except that it is arranged for wood firing, it is considered to be a faithful reconstruction of the original plant. The legend on the sign calls it the world's first refinery; but in recent years the Barnsdall interests have referred to it as America's first refinery in deference to the previously mentioned Scottish plants of earlier date. For the information in this column we are indebted to J. V. Brazier, assistant to the president of Bareco Oil Company of Tulsa.

The photograph won second prize in our recent cover contest. It was submitted by the Williams Studio of Pawhuska, Okla. In acknowledging the check that went with the award, C. F. Williams wrote us: "We have invested the money in a defense bond to the end that we may continue to take photographs and that you may continue to publish your magazine for the betterment of American industry."

Compressed Air Magazine

COPYRIGHT 1942 BY COMPRESSED AIR MAGAZINE COMPANY

VOLUME 47 — **August, 1942** — NUMBER 8

C. H. VIVIAN, *Editor*
A. M. HOFFMANN, *Assistant Editor*
J. F. KENNEY, *Business Manager*
J. W. YOUNG, *Director of Advertising*
W. M. HACKENBURG, *Advertising Manager*
D. Y. MARSHALL, *Europe*, 243 Upper Thames St., London, E.C.4.
F. A. MCLEAN, *Canada*, New Birks Building, Montreal, Quebec.

EDITORIAL CONTENTS

ADVERTISING INDEX

A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

CCA Member Controlled Circulation Audit.

Published by Compressed Air Magazine Co., G. W. MORRISON, *President;* J. F. KENNEY, *Vice-President;* F. E. KUTZ, *Secretary-Treasurer.*
Business, editorial, and publication offices, Phillipsburg, N. J.
Advertising Office, 11 Broadway, New York, N. Y., L. H. GEYER, representative.
Annual subscription: U.S., $3.00; foreign, $3.50. Single copies, 35 cents.
COMPRESSED AIR MAGAZINE is on file in many libraries and is indexed in Industrial Arts Index.


MINISTRY OF WORKS & BUILDINGS

COMPULSORY DISCLOSURE OF SCRAP METAL

(Defence (General) Regulations, 1939, No. 56AAA S. R. & O. 1942 No. 761)

EVERY OCCUPIER OF PREMISES in the areas of the United Kingdom specified below must furnish to the Ministry of Works & Buildings a return of any accumulation on those premises of 3 tons or more of metal suitable for scrap. Returns must be made on a prescribed form* within 30 days of 14th May, 1942, or of any subsequent day on which such an amount of metal suitable for scrap is brought on the premises.

The areas to which this notice applies are:

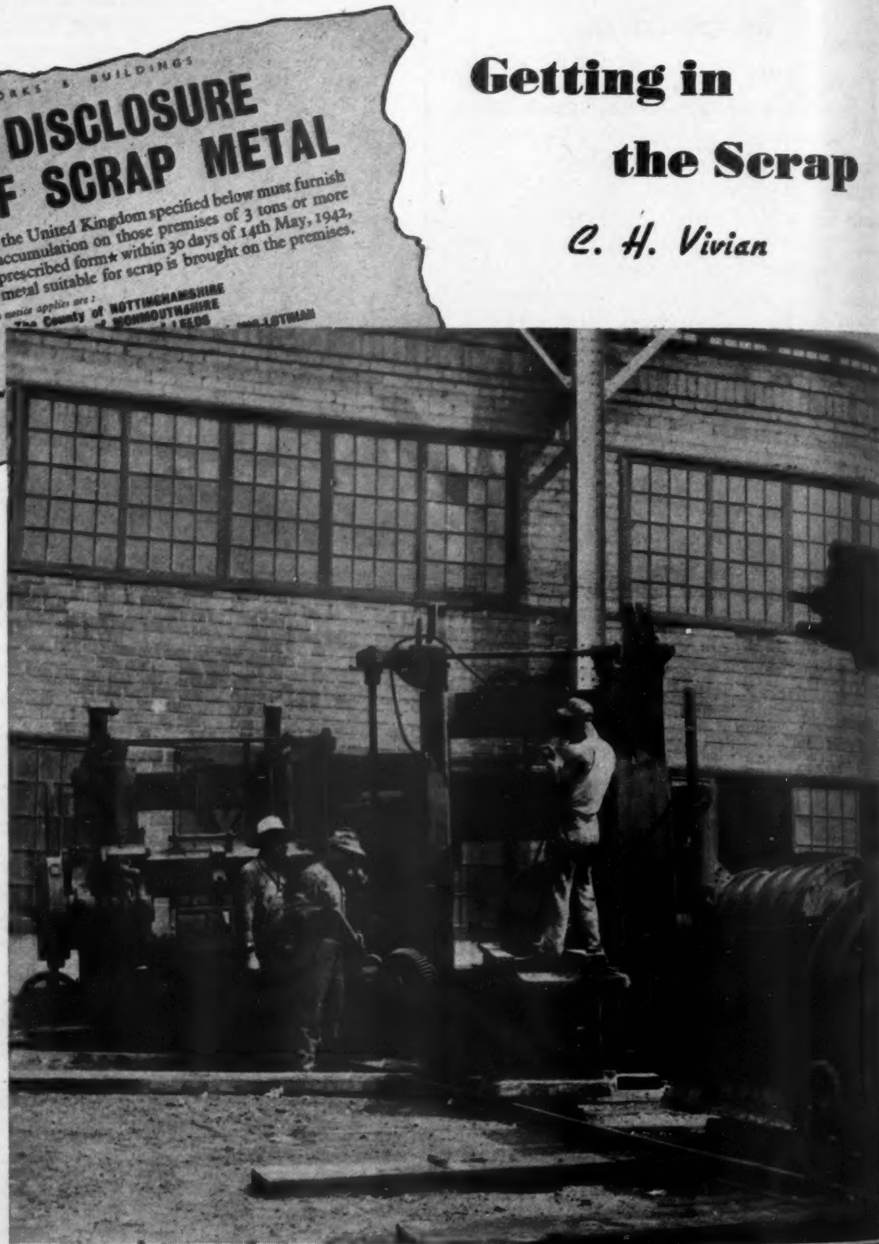
The LONDON CIVIL DEFENCE REGION
The County of ESSEX
The County of DORSET
The County Borough of BRISTOL
The County of NOTTINGHAMSHIRE
MONMOUTHSHIRE
LEEDS

Returns from other areas

Metal is deemed suitable for scrap if it is, or forms part of, any building, structure, machinery, plant, or article which is disused, obsolete or redundant, or

Getting in the Scrap

C. H. Vivian



ENLISTING SCRAP

The sketch below is a reproduction of a poster issued by the International Harvester Company to stimulate salvage. At the right is a picture of outmoded equipment in the Philadelphia plant of the Baldwin Locomotive Works that was used during World War I. It was dismantled for scrap during a drive at the plant that netted 1,800 tons. In England scrap is so vital to war production that holders of more than 3 tons of it are required to make a return to the Government. The notice at the top appeared in a recent issue of a British publication.

SCRAP materials—consisting largely of things that most Americans have traditionally allowed to clutter up their homes, farms, and industrial plants—are looming large in the news these days. High Government officials are going so far as to say that systematic collection of the materials that we normally waste may bring us victory in the war. "Get in the scrap with scrap" has become a militant slogan. Housewives are having impressed upon them the importance of cleaning out attics and cellars and of turning the odds and ends they find there into the channels of trade. They are told that one old electric pressing iron contains enough steel to make two helmets for soldiers, that 100 pounds of newspapers can be transformed into a carton for 35 antiaircraft shells, that 50 feet of worn-out garden hose will produce four army raincoats, and that 32 collapsible toothpaste tubes will yield tin for one fighter plane.

This emphasis on conservation is a new experience for our nation. We have never before known the true meaning of saving as it is understood by most European and Asiatic peoples. Compared with them we have been squanderers of just about everything we use. The reason has been that we have had in abundance many essential materials that were relatively scarce in some other parts of the world. Many students of international affairs have long contended that the first World War was

fought for control of the mineral kingdom and have been predicting ever since its termination that the struggle now in progress was bound to take place. As regards their possession of or access to certain vital natural resources, these observers have divided the nations into two groups: the "haves" and the "have nots."

The United Nations, especially the United States and Great Britain, have had control of a large proportion of the world's iron, copper, lead, zinc, petroleum, and other key minerals. These were not so important during the past centuries, but with the advent of the mechanical age they assumed a position of vital significance. Without them no land can gain or hold a leading place as a manufacturer and exporter, and unless a country can sell more than it buys it can never forge ahead. The Axis nations have been among the "have nots"; they have been dependent upon other countries for a large share of their essential minerals. Because of this scarcity of metals they long ago acquired the habit of reusing them.

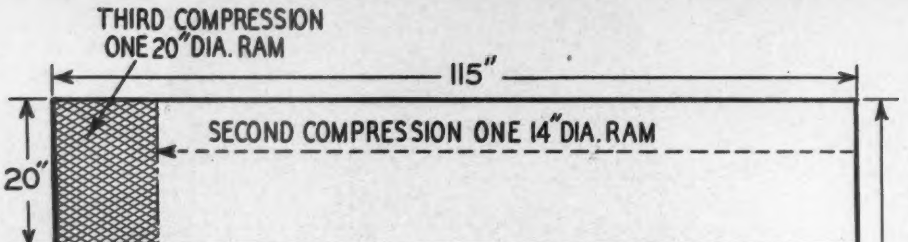
Dean Edward Steidle, of Pennsylvania State College, an exponent of the theory that international clashes will continue until there is a better distribution of essential minerals, recently wrote: "For 50 years the 'have not' countries have had to depend upon the salvaging of used materials to maintain their supply of minerals. Consequently, the metals in these countries do not find their ways to the city dumps. The extent to which minerals collect to form a pool of secondary metal is dependent in part upon their inherent properties and in part upon the manner in which they have been employed. The mineral fuels naturally are almost entirely consumed in use and no secondary recovery is possible. Most of the nonmetallics tend to be consumed in use and, aside from such valuable materials as gem stones, are seldom reclaimed for further use. Many of the metals, however, are used over and over again, and it is quite probable that a part of our gold hoard has been in existence for thousands of years and has been repeatedly used for coinage and jewelry. Naturally, the most valuable metals are the best guarded, and gold and silver and platinum are handed down from generation to generation and used in different forms repeatedly without loss."

In a way it is fortunate for us right now that we have been wasters, for it means that we have vast reservoirs of secondary materials on which to draw. It is difficult, however, to tap these resources and to start them flowing through channels that will lead to their reuse. Industries are, on the whole, responding well to the various governmental appeals, but the public has been somewhat lethargic. The drive for aluminum several months ago was successful, but later calls for rubber and miscellaneous scrap have not been wholeheartedly heeded by the average citizen.

There are two kinds of industrial metal scrap. The first is that which is produced in processing operations and is known as run-around or home scrap. This has been systematically salvaged by most manufacturing concerns for many years. The second is made up of obsolete or unused machines and tools and of miscellaneous accumulations. This is known as dormant scrap, because no effort is ordinarily made to dispose of it. Months ago the Industrial Salvage Section of the War Production Board urged plant executives to clean up and turn in this dormant scrap. The response, generally, was good and the results in some cases were startling. General Electric Company, for example, uncovered nearly 6,000 tons of metals of which 90 per cent was ferrous and 10 per cent nonferrous. Goodyear Tire & Rubber Company's housecleaning yielded 1,600 tons of metals. A midwestern railroad turned

WHAT HAPPENS TO OLD AUTO BODIES

Although they contain an average of 500 pounds of sheet steel, automobile bodies are worthless until their bulk is reduced so that they can be readily shipped and charged into furnaces. Steel jaws, actuated by hydraulic rams, squeeze them into neat cubes as easily as you would crumple a light paperboard box in your hands. These pictures, taken at the United Compressed Steel Corporation plant at Allentown, Pa., show a car body about to be dumped into the baling box of a press and the compacted mass into which it was transformed.



STEPS IN SCRAP COMPRESSION

1—Miscellaneous scrap is thrown into the baling box. 2—The right-hand wall of the box moves over to within 20 inches of the opposite wall. 3—The longitudinal plunger travels forward, compacting the scrap and pushing it into the recess at the far end of the box. 4—The final compression ram moves up from below, completing the bale, which is then elevated to ground level. These operations are normally performed with the cover over the baling box, but it was retracted to permit taking these pictures. The sketch just above shows the succession of steps illustrated and gives the dimensions of the baling box.

in 14,195 tons of iron and steel scrap, 46 tons of nonferrous metals, and 168 tons of waste paper.

In addition to starting their dormant scrap moving, industrial firms have introduced more effective means of collecting and sorting their home scrap. Many mills and factories produce all sorts of scrap ranging from different metals to various alloys of single metals. In order that the scarcer elements may be conserved without waste, it is necessary that care be taken in segregating them. In plants of the Wright Aeronautical Corporation this is done in a simple but ingenious way. Each metal-working machine is marked with a colored V, the color denoting the type of metal or alloy it handles. Wheeled receptacles, each of which also bears a colored V, are pushed through the shops at regular intervals. When a collector comes to a machine whose V matches the one on his cart, he takes the turnings or borings. This obviates subsequent sorting, saves time, and lessens mistakes.

Besides appealing to industries, Governmental representatives also ferreted out other sources which yielded large amounts of scrap. They bought the 60-mile, 100-year-old Susquehanna & New York Railroad that ran between Williamsport and Towanda, Pa., and junked it to salvage the iron and steel in its structures. They likewise acquired the defunct New York, Westchester & Boston Railway for $423,000 and got 15,000 tons of scrap from its 70 miles of track, 482 towers, and 30 bridges. Up in Minneapolis, Minn., the city gave Uncle Sam its oldest bridge, a span that had stood for 70 years. It contained 450 tons of wrought iron which will be converted into steel. Various other lucrative hauls have been made, and the scrap hunters have their eyes on countless other outmoded or unused public and private structures.

These are the more obvious fountainheads of scrap, and the easiest to draw upon. Supplementing them are the previously mentioned supplies that are scattered the length and breadth of the land on farms, on urban premises, and on dumps. It is impossible even to estimate how much metal, rubber, and other vital materials they harbor, but the quantity is known to be very great. Some of this scrap can be systematically collected, but to obtain much of it the Government must rely upon individuals to turn it in. Through the media of publicity, coöperative appeals from chambers of commerce and other organizations, and by devious

other methods, the public is being apprised of the patriotic duty each person can perform by responding to the call; and it goes without saying that if these efforts do not produce the desired results more stringent ones will be forthcoming. There is small likelihood, of course, that this country will ever have to enforce measures similar to those in effect in enemy nations where monuments, fences, manhole covers, and even some coins are being melted down to provide essential metals.

Few persons comprehend the immensity of the mass of metals that must be fed into the maw of the war machine to make it function effectively. By way of illustration, consider that one 35,000-ton battleship requires 62,000,000 pounds of steel, 2,000,000 pounds of copper, 1,000,000 pounds of zinc, 952,000 pounds of aluminum, 790,000 pounds of nickel, and 80,000 pounds of tin. The urgency of the situation was stressed by Chairman Donald Nelson of the War Production Board as follows: "Every weapon we produce today or tomorrow is worth 10 times as much as one we are going to produce in 1943. Every airplane that we produce is worth I don't know how many times one that we are going to produce in 1943."

Many communities are already doing splendid collecting jobs. In Coatesville, Pa., where the people are scrap-conscious because the Lukens Steel Company is located there, a campaign among householders yielded 30 pounds of iron and steel per capita. The metal was piled in a vacant lot in the business section, where it remained briefly as a monument to civic patriotism. The steel company bought it, and the money was donated by the scrap-givers to the American Red Cross. In Buffalo, Victory barrels in front of all firehouses serve as repositories for scrap donated by residents.

The importance of scrap iron and steel to the steel industry can be understood by considering the steel-manufacturing process. Half of the metallic content of a ton of steel is ordinarily obtained from iron ore and the other half from scrap. However, it takes 2 tons of Great Lakes ore to make a ton of pig iron, and its reduction requires 1 ton of coke and ½ ton of limestone, making a total of 3½ tons that must be transported to the steel centers. The aim is to produce 93,000,000 tons of steel in 1942. Assuming that the usual proportions of pig iron and scrap are used, this would call for 93,000,000 tons of hematite ore and 46,500,000 tons of scrap.

In a good business year 60,000,000 tons of iron ore is shipped on the Great Lakes. This year, by virtue of an early start, it is hoped to haul 88,000,000 tons before ice closes the waterways to navigation. To smelt this ore, there must be provided 44,000,000 tons of coke and 22,000,000 tons of limestone, and virtually all these materials must be moved by railroad. The combined shipments of ore, coke, and limestone will aggregate 154,000,000 tons and will impose a staggering burden on the transportation systems. Obviously, each ton of scrap that can be substituted for the raw materials just mentioned will lighten that load by 2½ tons. It is therefore important that we gather and send to the steel mills not only the 46,500,000 tons of scrap that will maintain the half-and-half ratio but also whatever surplus we can in order to substitute scrap for pig iron insofar as that is possible.

In 1941 the national consumption of scrap iron and steel amounted to 53,623,000 tons, as compared to 41,423,000 tons in 1940. During the first five months of 1942 it was at the rate of nearly 56,000,000 tons a year. In May it reached 4,857,000 tons, an all-time high. It should be borne in mind that not all this scrap was used for making steel, since foundries also utilize some and have been turning to it more and more this year by reason of the increasing difficulty of obtaining pig iron. On the whole, collection and delivery of scrap are keeping abreast of current needs, but the Government is concerned with a possible shortage next winter because the scrap industry is normally slack during that season. Accordingly, every effort is being made to increase shipments to the steel mills now to build up a winter surplus.

One of the most prolific sources of scrap metals is the automobile graveyard. There are some 20,000 of them in the country, and it is estimated that they contain 3,000,000 tons of metals, including copper, zinc, tin, steel, and cast iron. Right now these repositories for jallopies are considered so vital that the Bureau of Industrial Conservation has set up an Automobile Graveyard Section to see to it that the junking of cars proceeds at a steady pace. Last April their operators were ordered to sell all autos on hand by May 4 and to have the materials ready for de-

AIR-OPERATED COVER

The heavy-steel press cover (right) slides on rollers and is operated by a compressed-air piston underneath the building, as shown above.

livery by July 4, exceptions being made of parts that are still usable. This order put the yards on a schedule by which they have to dispose of their entire contents at least once every 60 days.

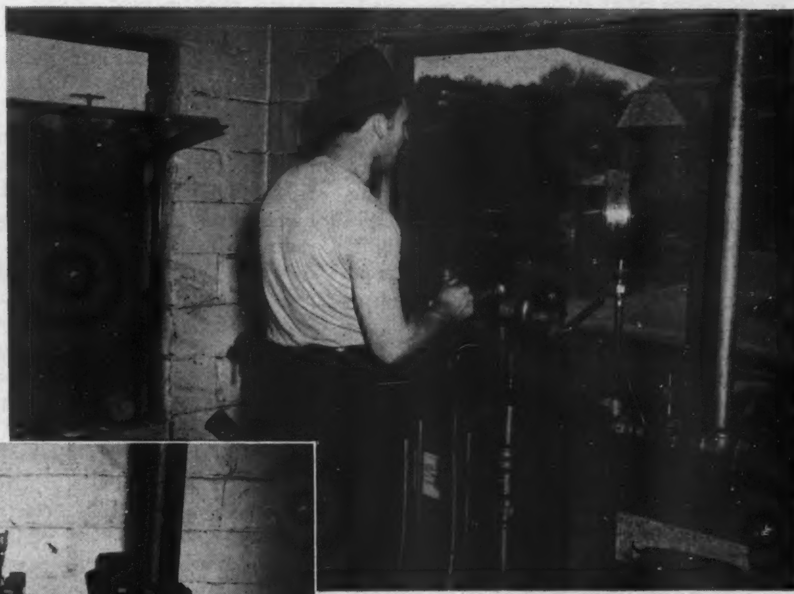
Even before this speed-up program was inaugurated, the rate of wrecking cars had been accelerated to such a point by April of this year that they yielded 350,000 tons of metal, or about 200,000 tons more than the monthly average for 1941. According to Government figures released on May 28, there were then in use 6,837,781 automobiles more than ten years old, and special appeals are being made to their owners to junk them. The shortage of gasoline, tires, and replacement parts, and the increasing difficulty of obtaining state-inspection-bureau approval of these outmoded cars are bringing more and more of them into the graveyards. It is predicted that during the next 2½ years 15,000,000 autos will be dismembered by the wreckers.

An average car provides about 1,750 pounds of metal. Much of this is in pieces such as engine blocks, wheels, axles, and gears that are thick in section and constitute no problem as to shipping or subsequent handling by the steel mills or foundries that receive them. After all these have been stripped from an automobile there still remains the carcass, a bulky, hollow hulk of thin sheet steel and wood containing, on an average, about 500 pounds of metal. For many years most of these bodies have been allowed to clutter up the landscape because it didn't pay to handle them. Some wreckers utilized their spare time in cutting them up and making fairly compact packages of them for shipment to the mills. But the steelmakers were not eager to have them. There is not much substance to thin sheets, and it took so many of them to make up a charge of the desired weight and so long to feed it into a furnace that there was an appreciable loss of heat and time. Moreover, the light-gauge material had a tendency to burn up, and much of its iron content was oxidized.

Steel mills that produced trimmings in the manufacture of sheets, and industrial plants that accumulated stampings and clippings from thin sections of iron or steel were faced with a similar problem even before the era of the all-steel-body car. It was solved by developing small hydraulic baling presses to convert the loose pieces into compact bundles. When automobile bodies and other bulkier kinds of scrap began to be abundant, larger and improved machines were brought out to handle them. Aside from being too small, the earlier presses were not satisfactory because they were capable of applying pressure from only two directions, and it was difficult to squeeze bulky objects into bales small enough to meet steel-mill specifications. As a result, there was built what is known as a triple-compression baler the first of which was introduced in this country in 1932 by the Galland-Henning Manufacturing Company of Milwaukee, Wis. As its name implies, this machine applies pressure in three dimensions.

Baling presses of this sort are now playing a big part in the war program. It is authoritatively estimated that about 25,000,000 tons of steel scrap per year is being gathered and supplied to steel mills by yards located throughout the country. Nearly half of this amount is received by them in the form of light-gauge material less than ¼ inch thick, and all of it is compressed into bales or, as the trade calls them, bundles. Not only automobile bodies but a wide variety of miscellaneous scrap such as old bedsprings, oil drums, ash cans, barbed and plain wire is compacted into neat blocks of metal that can be conveniently handled and that are dense enough to melt down evenly in the furnaces.

Some scrap yards have a baling press while others sell their product to separate concerns that specialize in preparing light material for the market. There are probably more than 100 of these establishments in the United States. The larger cities each have several of them while one press will suffice to serve a considerable area in a less densely populated region. The size of the press and the accessory mechanical equipment for handling the loose scrap and the completed bales vary with the material available for processing. Some plants have cranes with electromagnets or with grapple buckets for unloading the raw scrap and feeding it to the press,



CONTROL MECHANISM

The operator above stands where he can look down on the press and the men who feed it with scrap. When there is enough material in the box to make a bale he calls to the workmen or, with a compressed-air whistle, signals them to stand aside. He then runs the cover over the box and starts the squeezing cycle. Each ram is controlled by a lever through the medium of an air-operated valve (left).

as well as rather extensive conveyor systems for loading bales into cars for shipment. To facilitate operations, the baling box may be charged by means of a hopper. This is simply a large receptacle that is hinged to one side of the baling box and the top of which is flush with the ground surface when the former is in position for loading. While one lot of scrap is being compressed, another one is being placed in the hopper. Transfer to the press is effected by tilting the hopper with a compressed-air piston, just as one tips a pan to empty it. These various mechanical aids increase the speed of handling and consequently add to the daily output. Other yards do not have sufficient business to warrant all this equipment, but all of them have some sort of a conveyor for moving the heavy bundles from the press.

Typical of one of the smaller scrap-baling depots is the plant of the United Compressed Steel Corporation in Allentown, Pa., where some of the accompanying pictures were taken. It is located a few miles from one of the mills of the Bethlehem Steel Company, to which it sells all its product. The press was put in about two years ago, and there is not another within 60 miles of it. The concern operates eight trucks to gather material from auto graveyards, scrap dealers, industrial plants, and even from individual farms and urban residences. It reaches as far afield as 90 miles in an area that includes the cities of Scranton and Hazleton, Pa., and Newark, N. J. In addition, some scrap is delivered to the press by sellers, but in the main the company has to run its own cars to insure a supply.

This recalls the fact that there has been a great change in the scrap-collecting business in recent years. Formerly there were junkmen, or scavengers, who regularly visited city dumps and systematically canvassed town and countryside buying up miscellaneous material which they sold to intermediate dealers or, in the case of light-gauge scrap, directly to presses. They received as little as twenty cents a hundred for the latter, but were able to eke out a living. Nowadays, most of these itinerant collectors have better-paying jobs in defense plants and the scrap-metal industry must largely forage for itself.

The trucks come into the baling yard with a heterogeneous assortment of materials which they dump on each side of the press. Seldom are piles of more than a few truckloads allowed to accumulate, for the bundling crew can keep abreast of collections by working an average of ten hours a day. This steady flow of scrap is desirable from an operating standpoint, as it has to be moved only once and then but a few feet from pile to press. This reduces labor costs to a minimum, especially in a yard like the one under consideration where all the raw material is handled manually. It is incumbent upon the baler to sort the metal, and this is done by the press feeders. To encourage them to do a good job, the owners permit them to divide any profits accruing from the sale of nonferrous materials. Spurred on by this incentive, they have eagle eyes for bits of such metals as brass, copper, zinc, lead, or pewter, which may be either loose or attached to pieces of iron or steel.

Galvanized or tinned materials also must be segregated so that they can be baled separately. Steel mills will take a certain amount of galvanized scrap, but do not want it mixed with the regular material. They will not accept tin cans or other tin-plated material because the metal has an injurious effect on the steel. The baling yard naturally tries to exclude tin from the raw scrap that it buys, but finds it impossible to do so. The tinned material is bundled and put aside. About the only prospective purchasers for it are foundries that make sash weights or similar products which need have little strength, and the supply is greater than the demand. Numerous detinning works are now being put in service in the country, but so far no process is available for removing tin from metal that has been tightly compacted.

The press in the plant of the United

Compre sed Steel Corporation was made by Galla ıd-Henning Manufacturing Company ar.d is next to the largest of five sizes constructed by that concern. The baling box is 100 inches long, 54 inches wide, and 44 inches deep; has a content of 145 cubic feet; and will handle an entire automobile body. As an accompanying sketch shows, there is a recessed space—15x20x44 inches—at one end, and it is in this that the bale takes final form. The press is built of heavily ribbed, annealed-steel castings and is lined with renewable steel plates. The scrap is compacted in three stages. The first compression is from one side, one wall being moved in until it is within 20 inches of the opposing one; the second is longitudinal and forces the material into the recess; and the last compression is from below. The product is a bale measuring 20 by 15 by approximately 20 inches. The latter dimension, representing the height of the bundle, varies with the amount of material loaded into the box.

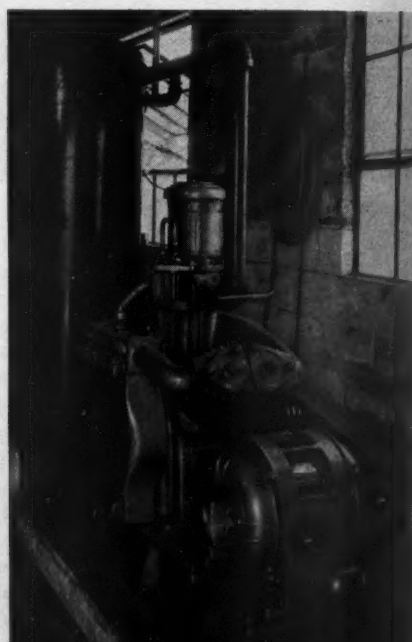
Before compression starts, a heavy cover is slid over the box, and this constitutes the top of the press. At its forward end there is a raised portion that fits under a heavy steel yoke above the final baling chamber, thus giving it the rigidity to resist the force of the compression stroke exerted from below. When the cover is retracted, the vertical ram elevates the completed bundle to ground level, where the cover then pushes it on to a roller conveyor that leads to a gondola car spotted on a depressed track a few feet away. A second conveyor, running at right angles to the first, permits moving bales to a storage area, if desired.

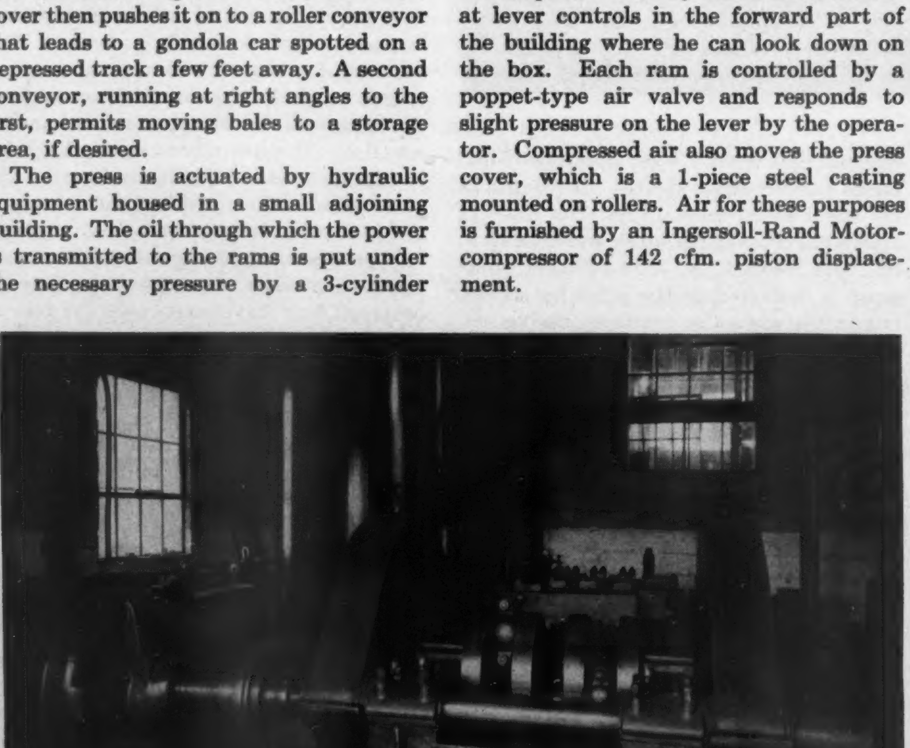
The press is actuated by hydraulic equipment housed in a small adjoining building. The oil through which the power is transmitted to the rams is put under the necessary pressure by a 3-cylinder pump that is gear-driven by a 100-hp. motor. The equipment is designed for 2,000 pounds pressure per square inch, but in this case it is being operated at 1,500 pounds. The first or side compression is effected by two 8-inch-diameter rams, and the second or end compression by a single 14-inch-diameter ram. Both of these have fixed strokes, the aim merely being to reduce the plan dimensions of the bale to a size that will enable it to fit into the recess where final compression is accomplished by a 20-inch-diameter ram. This does not have a fixed stroke but moves upward until the density of the scrap is such that further compression is impossible with the power available. The pressure exerted by this ram reaches 471,000 pounds, and when this is transmitted to its 15x20-inch head in contact with the bale it equals 1,570 pounds per square inch. Should there be occasion to do so at any time, the full 2,000-pound pressure of the oil pump can be applied and the third ram made to develop a pressure of approximately 628,000 pounds, or 314 tons. Under these working conditions light scrap can be compacted until its density is 35 to 40 per cent of that of solid steel. The rams are retracted by counterweights that travel up and down in a concreted pit beneath the machine. In the case of the newer presses, however, they are returned by compressed air.

The press is run by one man stationed at lever controls in the forward part of the building where he can look down on the box. Each ram is controlled by a poppet-type air valve and responds to slight pressure on the lever by the operator. Compressed air also moves the press cover, which is a 1-piece steel casting mounted on rollers. Air for these purposes is furnished by an Ingersoll-Rand Motor-compressor of 142 cfm. piston displacement.

The bales weigh from 450 to 800 pounds each, depending upon the amount of material put into the box. This is controlled by the operator, who signals to the workmen handling the scrap when to stop loading. The quantity that can be readily compacted at one time depends on the nature of the material. Some of it is so bulky as to fill the box and still not make a heavy bundle when it is compressed. The weekly output of the press averages 1,000 tons.

The Office of Price Administration put all iron and steel scrap under maximum price control last April. At the same time it regrouped the grades that had previously been established by the trade in the interest of simplification. Material of the sort described is known as Dealers' No. 2 Bundles, and in the price schedule is grouped with five other grades all of which are known as open-hearth grades. The price per gross ton of 2,240 pounds received by the press operator varies in different parts of the country, and out of it must come freight charges to the steel mill. The base price at Bethlehem is $18.25. In general, light-gauge scrap takes on an added value of approximately $6 a ton because it has been subjected to the baling process.

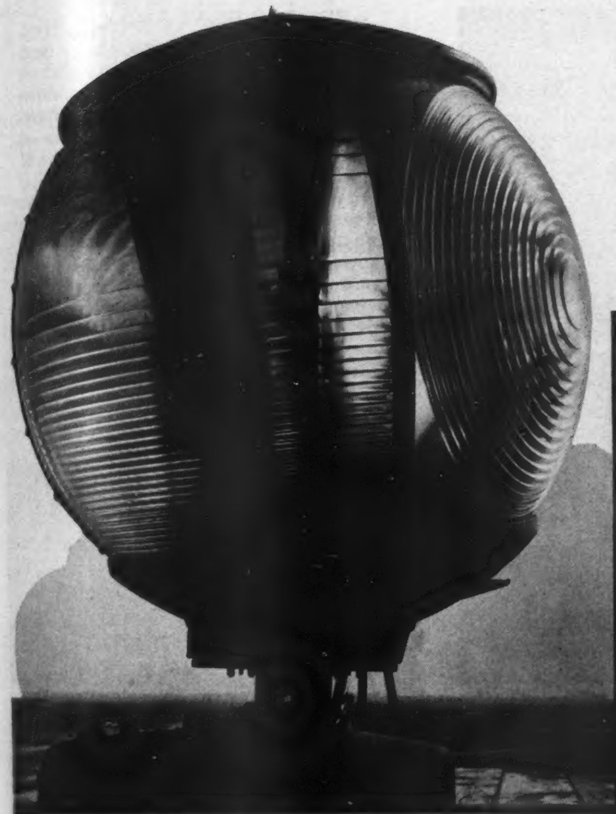


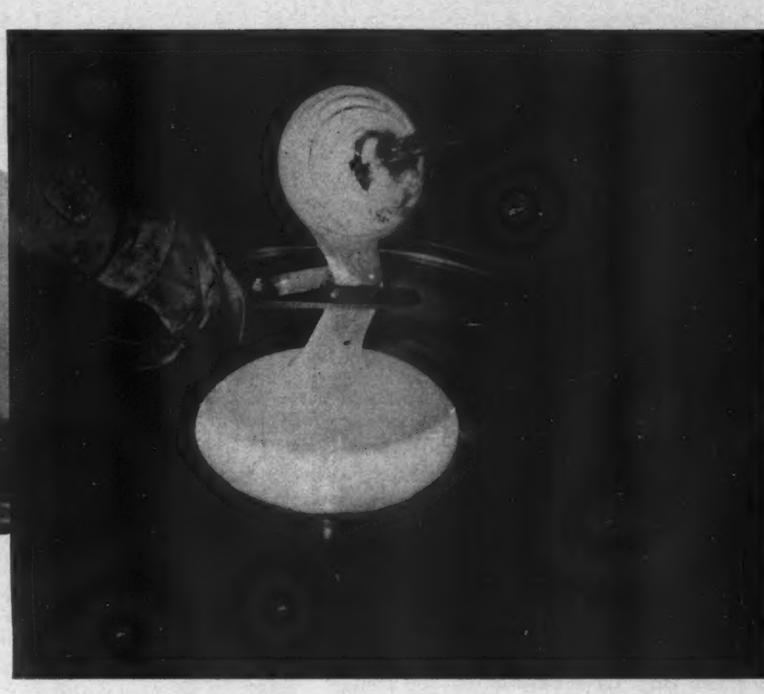


OPERATING MACHINERY
The hydraulic rams that form the bale are actuated by oil under a pressure of 1,500 pounds per square inch. This pressure is built up by the 3-cylinder reciprocating pump shown at the left. The control valves and the press cover are operated by compressed air at 100 pounds pressure supplied by the Ingersoll-Rand Motorcompressor pictured above. A press of the size in question, with auxiliary equipment, weighs more than 80 tons and calls for an investment of around $40,000.

Glass in the War*

*T. J. Thompson***





SCISSORS CUT IT

Immediately after the red-hot gob of glass shown at the right is cut off the "punty" iron it will be pressed into a large front glass for a floodlight. The lenses in the revolving airport beacon were made at the Corning Glass Works.

ONE of the best cavalry generals that ever straddled a horse was a Confederate rebel by the name of Forrest. He was a backwoodsman and didn't know much about grammar, but he did know how to win battles. Also, he knew how to express himself simply and succinctly. Forrest ascribed his success to one basic tactic which, in his own words, was "Git thar fustest with the mostest men." Today that precept must be modified somewhat; it could read "git thar fustest with the mostest fire power." The men in our armed forces who will control and direct that fire power are anxiously awaiting delivery of it to them in Australia and elsewhere, and it is our common hope and aim that the expression "too little and too late" will shortly vanish from the reports of courageous but ill-equipped generals and admirals of the allied forces. In the creation of that fire power, glass is playing a vital part not only in releasing other materials that are more essential for war purposes but also directly as a construction material in war industries.

In the 28 years since the beginning of World War I, glass has made an increasingly important place for itself both in industry and in the home. Perhaps the most outstanding milestone in its progress was the development of hard borosilicate glasses by Sullivan and Taylor in 1914. These constituted a long step forward in the search for glass having the highly desirable properties of quartz—the perfect glass—but which, unlike quartz, could be readily melted and formed into usable shapes. Their remarkable heat and chemical resistance, coupled with excellent mechanical and dielectric qualities, instantly opened gates to new fields of application. Stemming from and stimulated by this discovery, research and development work of an ever-broadening scope have released a flood of information about glass and its properties and how to put it to practical use.

Another major milestone was the subsequent discovery of ways and means of doubling or tripling the mechanical strength of glassware and improving still further its resistance to heat shock by tempering or heat-processing. A well-known example of this is Flameware that can be set on open-flame or electric-range heating elements. Then there is tempered plate glass which is now coming into common use as all-glass doors in store fronts.

More recently, the remaining gap between glass and quartz has been nearly closed through the development of 96 per cent silica glass by Hood and Nordberg. Their process not only makes possible the commercial production of quartzlike ware by conventional glass-forming methods but also permits the use of the old ceramic art of "slip-casting," thus making this unique ware available in sizes and shapes and an intricacy of pattern previously unattainable in glass.

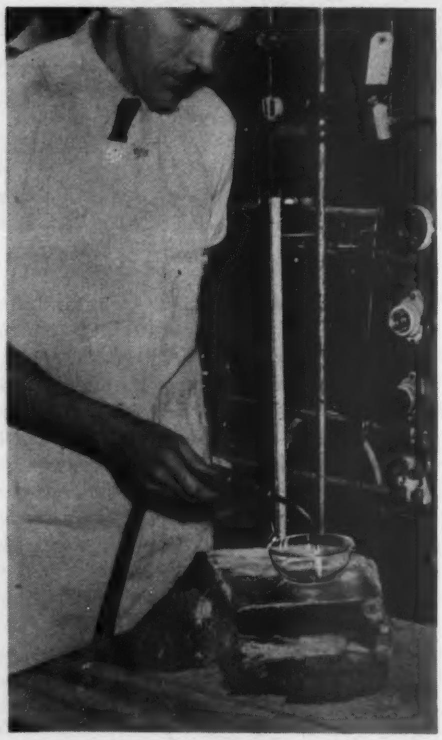
Despite the great strides that have been made in the utilization of glass, there is astonishingly little sound knowledge of its properties and potentialities among scientific, engineering, and business groups, to say nothing of the general public. Perhaps this is because many important applications are highly specialized and therefore hidden from public view. It is the present purpose to bring to light some of the little-known and long-standing uses of glass that have added significance now and likewise to report on those advances about which we can talk without giving "aid and comfort to the enemy." As regards the latter, there is little to fear, because Germany had for years forced upon industry and public the wide-scale adoption of glass in anticipation of a metal shortage in the event of a declaration of war. We know, for instance, that glass piping has been extensively employed there in the chemical and in the dairy and food-products industries, as well as for domestic plumbing. This has resulted in a new trade or craft called "glass-plumbing." Frankly, we would like very much to know just how far Germany has gone

*Essential substance of a paper read before the American Ceramic Society.

**Manager, Industrial Division, Corning Glass Works, Corning, N. Y.

RESISTS HEAT AND COLD

Examples of Corning's new 96 per cent silica glass that will not break when subjected to sudden temperature changes. At the bottom, a small bowl of the material is resting on a cake of ice while being subjected to the heat of an oxy-gas flame. The evaporating dish at the left was the first commercial item made of this ultralow-expansion glass. The household ware immediately below shows the amazing shrinkage the glass undergoes during manufacture. When it came from the preliminary molding operation it was 12 inches in diameter (left); after being exposed to the new process it measured 10½ inches.



in the use of glass in the "Ersatz program."

One of the earliest industrial applications of borosilicate glassware was for piping hot, corrosive solutions in the chemical industry. That was more than sixteen years ago. Some of the old installations are still in operation and are by now literally worth their weight in gold because they have eliminated the costly and frequent replacements that would have been necessary if they had been made of the usual metals and alloys. But even the progressive chemical industry was for years reluctant to adopt glass piping because of fear of breakage in rough-and-tumble operations with unskilled help. In many cases, the initial systems were installed in desperation after all else had failed to solve vexatious corrosion problems. But, bit by bit, the first lines were enlarged and new ones added when the pioneers found that their fears were unwarranted. Many users reaped an unexpected dividend. Not only did the glass piping eliminate corrosion but it also improved the quality of the product by preventing metallic contamination. Further, they found that trouble can't hide behind transparent glass.

As time went on there followed a succession of improvements in design, fittings, and fabrication methods until, today, every major and many smaller producers of chemicals in this country use substantial quantities of glass piping for conveying, heating, cooling, and the absorption of a myriad of corrosive liquids or gases many of which are essential to the making of explosives, poison gases, high-octane airplane fuels, magnesium, and other war materials. Manufacturers of drugs, pharmaceuticals, reagent chemicals, vitamins, and biological compounds likewise have serious corrosion problems, but they are mostly concerned about the purity of their products. In many instances glass equipment has proved to be the answer.

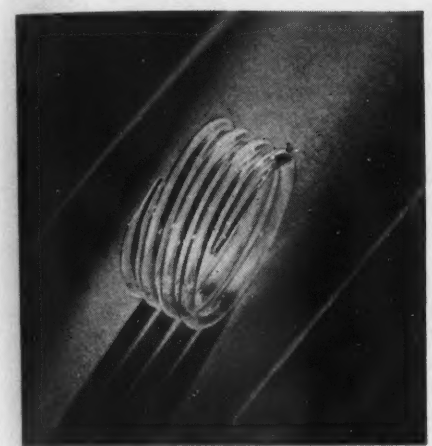
Next to learn the advantages of glass piping were food and beverage industries, particularly those working with acidic products such as tomatoes, fruit juices, vinegar, pickling brines, and organic acids, as well as with phosphoric and sulphurous acids. Important as the corrosion problem is in the handling of such fluids, the maintenance of sanitation is an even more difficult one. Fortunately, the smoothness of glass makes it easy to keep the lines clean. Simple flushing with cold and hot water or cleansing agents, followed by sterilization with steam or solutions, enable an operator closely to control the bacteria count. Because of its noncrystalline structure, glass does not readily take and hold films of impurities and undesirable scale, and corrosion cannot form pits in which bacteria can hide. Furthermore, transparency is not the least of its merits because instant inspection of the interior walls leaves nothing to the imagination of workman or supervisor. Stainless steel and aluminum, formerly considered indispensable in food service, are thus released in substantial quantities to armament factories.

The latest innovation in glass piping is the electric welding of sections in the field to eliminate or to reduce the number of joints. By means of portable equipment, generating high-frequency current, the tube ends can be welded together in place and subsequently annealed in short order. This method will undoubtedly find widescale use in the chemical industry because it does away almost entirely with the need of metal flanges and special gaskets for flanged piping.

Right now the most promising field of application of welded-glass piping is the dairy industry where tinned-copper or stainless-alloy equipment with quickly demountable joints to facilitate dismantling and reassembly is standard. The sanitary codes of most states specify that the component parts of milk-handling equipment be dismantled, thoroughly cleaned, and sterilized after each "run."

TUBES IN THE MAKING

At the right is an expert glass blower and manipulator in the main plant of the Corning Glass Works drawing out a long piece of tubing. When finished it will be of the same diameter as that on the floor. The picture at the bottom shows how thermometer tubing is drawn vertically in a tower, which is said to be the only one of its kind in the world. The beginning of such a tube is seen in the well at the extreme right. The spring directly below is made of glass tubing. It was designed to develop a force of 1 pound when deflected 3/32 inch and gave no indication of failure after 8,000,000 deflections.



This is, of course, time-consuming. Recent experimental work has shown that jointless glass lines can be thoroughly cleansed without dismantling and that the bacteria count can be closely controlled. Ultimately, this would mean a substantial reduction in cleaning costs. At the ends of the piping, where connections are made with coolers, filters, tanks, valves, etc., sterilizing can be done quickly with small portable devices.

Pending further tests with welded-glass pipe in the dairy industry, and approval of its use by state sanitarians, it will be possible to utilize special Pyrex tubing. Means have been developed for securely connecting it to standard metal fittings such as elbows, tees, valves, etc., which will probably still be made available in limited quantities. This glass-metal combination can be readily dismounted and cleaned. And by means of simple portable machinery the piping can be cut accurately to the desired lengths, fused, and annealed in the field so that ordinary dairy workmen can make initial installations and quick repairs with standard glass tubing from local stocks.

Supplemental to the piping there is a new line of glass centrifugal pumps. Since the introduction of the first model about three years ago, hundreds of them have been placed in operation and come through in some of the toughest services in the chemical industry. Although well armored and protected by metal, the units are so designed that the liquids come in contact with no metal. Their volutes, headplates, and impellers are of glass, and these parts, incidentally, are finished to dimensional tolerances as close as those of high-grade metal pumps. A unique stuffing-box arrangement employs a rotary ring seal the rotating member of which is made from 96 per cent silica glass with so great a thermal shock resistance that the pump may be allowed to run dry without fear of breakage from the frictional heat thus generated in the stuffing box and from the resultant thermal shock when cold liquid again enters the pump. The smoothness of the ring's operating face enhances over-all pump efficiency by reducing friction drag, and chemical stability assures long life and trouble-free operation in corrosive service that quickly destroys the highest-grade metal shafts and stuffing-box assemblies. The pump impeller is an outstanding illustration of the manner in which glass and metal can be joined to provide a strong assembly having the advantages of both and the weaknesses of neither. This is accomplished by molding the glass impeller disk integrally with a hollow stub shaft having longitudinal splines and radial grooves. A metal plug with corresponding splines and grooves is dropped in and permanently locked in place with a low-melting metal alloy.

An astonishing quantity of floats is needed by the fishing industry for the control of the nets. Aluminum, steel, and glass have been largely used for this purpose, but now the first two are hard to procure and the supply of cheap glass floats from Europe, Japan, and Russia is not available. Mechanisms by which our total requirements can be produced from glass at low cost are in process of development.

The art of forming glass on a mandrel to extremely precise shape and size is no longer new, but great strides are being made in further utilizing this unique combination of qualities. Upon this great accuracy, coupled with the transparency and mechanical strength of glass, are based new instruments for the visual indication of the flow of liquids or gases under pressure, as well as for the construction of precisely formed mechanical parts. Rotameters, of the type now widely used in the chemical industry, are an example, but some of the later interesting applications in warplanes cannot be mentioned here.

The recent development of fluorescent-

tube lighting is opportune from a number of viewpoints. With a saving of 55 per cent in electric power it gives the same illumination as the filament lamp, and the quality of the light is such that workers are subjected to less fatigue, thus increasing their efficiency and productiveness now when they are so urgently needed. Furthermore, the tubes last 2½-3 times as long as incandescent bulbs. Formerly the tubes of fluorescent-light fixtures had to be made of lead glass, but since then suitable compositions have been developed which are free from lead. In addition, end cups and reflectors are fashioned of glass instead of metal.

Commercial and residential lighting fixtures such as bases and columns for table and floor lamps are in production, and it is expected that accessories such as outlet plates, socket shells and covers, and silvered reflectors for indirect illumination will shortly be available in quantity, all replacing mostly copper and brass. Not to be forgotten as a metal conserver is the all-glass, sealed-beam headlight for automobiles just coming into widespread use. It does away with the need of a plated-brass reflector shell and markedly improves road illumination.

In this war more than any other it is of paramount importance that the home front be safeguarded, and in the face of curtailed supplies of metalware for preparing and cooking food, past and current developments in glass stand in good stead. Even in cases where small metal and plastic accessories have served in combination with glass, efforts are being made to displace them. Handles, covers, and percolator baskets and pumps are now made of glass instead of stainless steel, aluminum, or plastics. And for coffee makers of the double-bowl vacuum type there is a ground-joint construction that eliminates rubber bushings.

Following are listed newer, interesting glass applications of which some are still under investigation or have not yet attained large-scale commercial production:

Tubes of 96 per cent silica glass are being used to shield sensitive thermocouples against corrosive furnace atmospheres at temperatures up to 1,000°C. (1,832°F.), thus displacing special alloys. Clear glass of this kind, because of its heat resistance and transparency to infrared rays, has demonstrated unique characteristics as a soleplate for electric irons.

Preliminary experimental work with sintered mixtures of glass and metal powders promises to result in useful materials of construction.

Cessation of imports from Europe necessitated development of the special glass compositions that are required for making glass eyes, and these are now available.

Roadside reflector disks, mounted at 35-yard intervals to outline highways, are proving to be real aids to night driving, particularly over winding roads in fog, rain, or snow, and may play a vital part in blackouts or dimouts. In another highway service, minute glass spheres, approximately 1/100 inch in diameter, are dusted on newly painted center stripes to improve night visibility by increasing the intensity of the backward reflection of automobile headlights.

Special floats have been designed to replace the metal ones formerly used in humidifiers in domestic warm-air heating systems. Glass has proved to be more durable than copper for this purpose because of the corrosive nature of the saturated salt solution that quickly forms in the water pan at high temperatures. Glass floats are also available for toilet flush tanks, thus displacing copper.

Potentially, the most useful present-day work of glass in plumbing is that of supplanting copper and wrought iron for piping mostly 1 inch in diameter or less. Glass is sufficiently strong for the pressures involved and can easily withstand the thermal shocks of hot-water service, besides being resistant to scaling. However, it must be confessed that a really satisfactory simple joint for plain-end tubing has not yet been developed, although efforts in this direction are continuing.

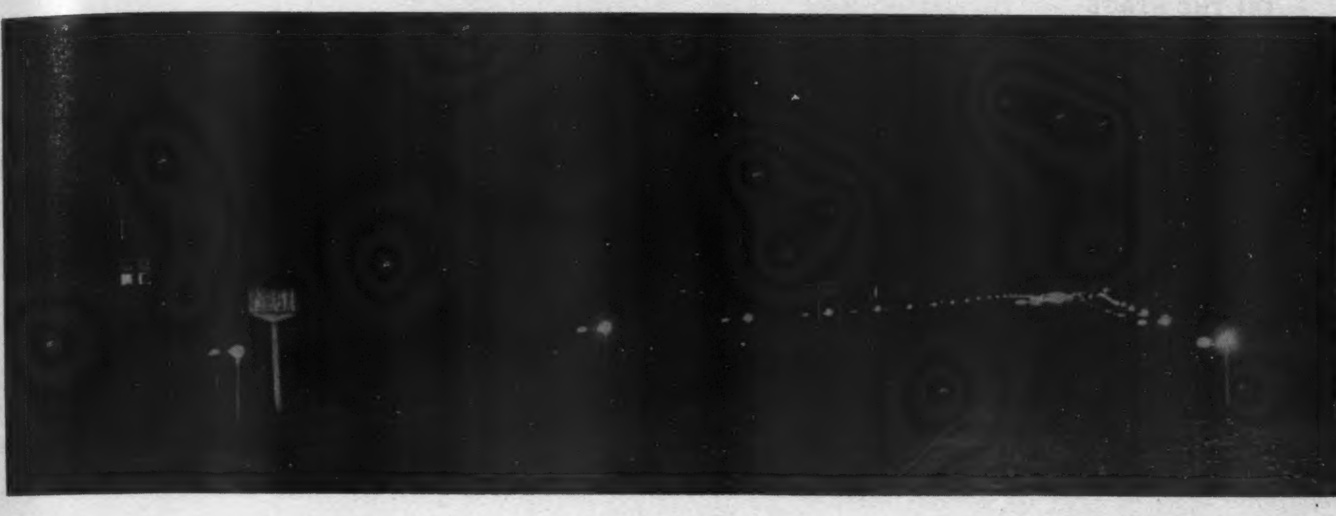
For making precision gauges of the snap and plug types, borosilicate glasses offer a number of advantages, among which are hardness and resistance to abrasion. Furthermore, their low thermal expansion and low thermal conductivity minimize dimensional changes resulting from temperature variations due to handling or other causes. It is reported that glasses of this kind are used for the purpose in England, and American and Canadian gaugemakers are following suit.

Borosilicate and 96 per cent silica glasses are finding increasing application in the textile industry where they are appearing in the form of thread guides, rollers, and bars of assorted shapes and sizes. Large and small rollers of glass are being sub-

Photo by Ayres A. Stevens

JOINT AND PIPE

The hard, smooth, impervious surface of Pyrex glass, together with its resistance to heat shock and its immunity to the attack of reagents, have made it an invaluable material for pipe lines. The transparent arteries are being used for the transmission of acids, chemicals, and food products—juices—for which cleanliness is essential. Note the glass blocks in the structure at the right.



NO ELECTRICITY REQUIRED

This is a night photograph of a highway section between East Corning and Big Flats, N.Y., provided with Reflex light units to facilitate night driving. The disks are mounted at 35-yard intervals.

stituted for metal ones in steel pickling tanks, where they are exposed to sulphuric acid, and in many other services such as conveying and guiding delicate organic films through chemical treating baths without scratching them.

The shortage of cork for low-temperature insulation and of magnesia, asbestos, and other materials for higher temperatures will shortly be at least partially alleviated by foamed or cellulated glass. This new product, called Foamglas by its makers, the Pittsburgh-Corning Corporation, will be available in standard blocks and special shapes having a density of only 10 to 11 pounds per cubic foot and a thermal conductivity that compares favorably with cork in actual service. Since the low density is attained by small totally embedded gas bubbles, the material has no interconnecting pores or channels and cannot become soggy or lose efficiency upon exposure to water or dampness incident to refrigeration or other wet service conditions. Its upper temperature limit of 1,000°F. permits a broad range of industrial applications. But of special interest is its relatively great mechanical strength as compared with most insulating materials. It has a tensile strength of approximately 100 pounds per square inch and a crushing strength of 150 pounds per square inch, thus providing substantial load-carrying capacity. Also, it can be walked upon without serious damage. Aside from insulation, there are other potential fields of usefulness such as life boats and rafts, life preservers, and pontoon-bridge floats which are particularly timely now. When Foamglas becomes commercially available in the near future, the Armstrong Cork Company will collaborate with the Pittsburgh-Corning Corporation in marketing it in the cold-storage field.

For many years Pyrex battery jars have been used for telephone substations, railroad signal service and for other stationary work. Glass automobile batteries have not been introduced in this country until recently largely because of the difficulty of molding the partitions between the cells. This has now been overcome by further development of the technique employed in the manufacture of glass building blocks. It will thereby be possible to substitute it for the rubber and asphaltic compositions now in general use.

Fibrous glass has been well publicized and needs no detailed recounting here, but it is worthy of note that Fiberglas has led to substantial reductions in the size and weight and quantities of materials for electric motors and other electrical machinery. Special glass textiles constitute a part of important military equipment; and special insulating materials effect economies in weight, space, and construction time of our warships, tankers, cargo vessels, and airplanes. But for the availability of Fiberglass there would by now be a critical shortage of asbestos for military and industrial purposes.

Among the unseen but vital "innards" of ammeters, voltmeters, and other sensitive electrical instruments are pivot bearings. Because the steel pivot often has a radius of only 0.001 inch, relatively light loading results in enormous pressures on the jewel. Stresses of hundreds of tons per square inch are not unusual. To withstand them without crushing or wearing too rapidly, it has been necessary heretofore to use sapphire jewels. These are no longer available in sufficiently large amounts; but, fortunately, glass compositions have been developed that possess the needful resistance to impact, abrasion, and crushing. They are being made into instrument bearings on a commercial scale.

To the general public it is astonishing that a material as stiff as glass is suitable for springs. Actually, glass has a number of properties that commend it for certain types of spring construction. It is more elastic than steel and retains its elasticity over a broad temperature range; it is immune to acid attack; and third, and most remarkable of all, is its apparent immunity to fatigue. Of course it is not so strong as spring metals even when tempered, but when so treated it can be safely used at fiber stresses of 2,000 pounds per square inch and more. For lightly loaded springs this is ample.

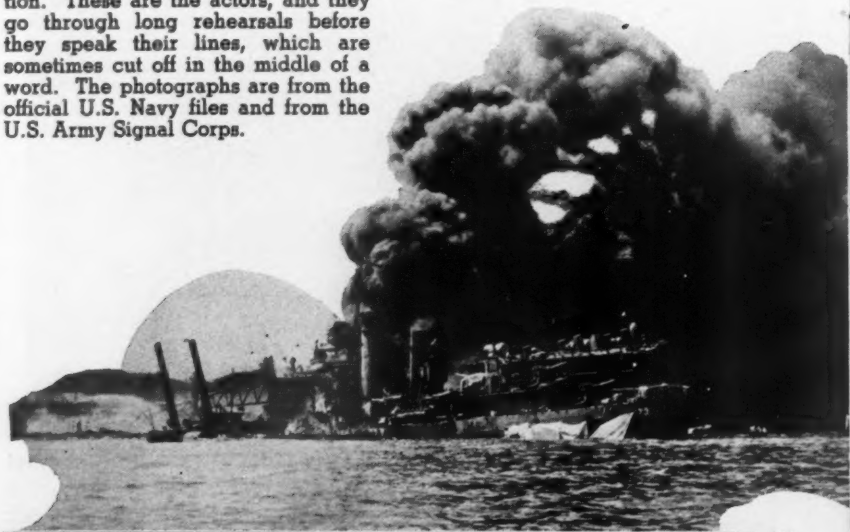
Conventional electrical insulators of glass in numerous sizes and types have been widely used for many years, and today it is possible to utilize them even more extensively because of recent advances and improvements in fabrication methods by which glass can be economically formed into intricate shapes with accurate threads, holes, etc. Also, the new process permits the incorporation in specially designed insulator parts of a rather broad range of predetermined electrical characteristics. "Loss factor," for instance, which is a particularly important one in the case of ultrahigh-frequency radio equipment, can be held to very low figures while still retaining other desirable electrical characteristics.

The indifference of glass to wide thermal changes, coupled with a low expansion coefficient and dimensional stability, make it particularly well suited for coil forms which must be exposed to atmospheric temperatures of −50° to 160°F. and also for end plates for coil forms, mounting blocks, coaxial line spacers, etc.

Certain developments and applications of glass in connection with the war effort cannot be detailed here. Among them are some that have a bearing on ammunition and ordnance, on new optical glasses and methods of producing them. But from this brief review it is clear that glass is playing a vital role in these critical days even though some of its services are of the "substitute" variety—of temporary interest only. But it is equally clear that the ever-expanding knowledge of its properties and uses discloses it to be an astonishingly adaptable material, one that will play an increasingly important part in rebuilding and enhancing our standard of living during the reconstruction period after the end of hostilities.

ON THE STAGE

Modern war is like a theater. The spotlight plays on the ships, tanks, planes, and other means of destruction. These are the actors, and they go through long rehearsals before they speak their lines, which are sometimes cut off in the middle of a word. The photographs are from the official U.S. Navy files and from the U.S. Army Signal Corps.



These Machines Went to War

THERE was a time when man fought face to face with man, a short sword his only weapon, a rawhide shield his only protection. Victory depended largely upon individual strength and skill.

Today warfare is a titanic, terrifying struggle between huge mechanical giants created by man—veritable Frankenstein monsters against which his strength is a puny, insignificant thing but which give him the destructive power of a thousand men.

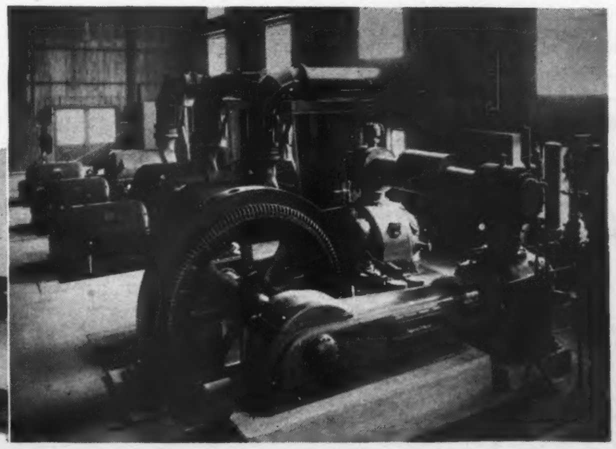
The scope of the battleground challenges the imagination, reaching as it does far above the clouds and encompassing at the same time vast trackless expanses of ocean and every known type of terrain.

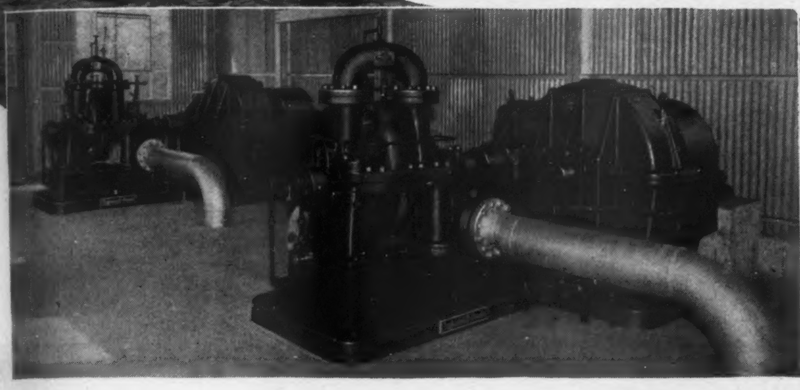
Tanks, grotesque giants of steel, inexorably smash their way through jungle forest or, like prehistoric beetles, scurry belligerently over desert sands, crushing everything in their path and leaving ruin and shambles in their wake.

Planes, winged roaring monsters, twist and dodge in mortal combat high above the earth or swoop like hawks out of the clouds at speeds of 4 and 5 miles a minute and loose death and destruction on their intended victims.

Battleships, massive floating fortresses, shoot 1,000-pound explosive shells distances of 5 miles and more—destroyers, like steel-clad barracudas, swarm to the kill—submarines, rising out of the depths, strive to catch a victim unawares.

In this warfare of machine against machine the destruction is appalling. In a few fleeting moments thousands upon





hese Machines Stayed Home

J. F. Nesbitt

BACK OF THE SCENES

Less spectacular than the fighting machines, but no less important, are the myriads of industrial mechanisms that back them up. Shown here are compressors and blowers in a copper refinery, pumps that push oil through a pipe line, a riveting hammer in an airplane factory, oil-field compressors, and rock drills in a lead-zinc mine.

thousands of tons of iron, steel, aluminum, copper, and other materials are lost irretrievably. Countless numbers of gadgets, precision instruments, guns, motors, engines, castings, and fabricated parts representing the result of millions of work-hours are reduced to smoldering heaps of scrap.

However, the foregoing is only the headline material—the awe-inspiring climax that quickens the pulse and stirs the imagination. At the other end of the tenuous, embattled supply line, far behind the noise, fanfare, and kaleidoscopic action of the battlefield, another titanic mechanical struggle is being waged—a prosaic but none-the-less grim struggle against time to replenish and augment the machinery of war.

Industry, that Cyclopean servant of mankind, which in peacetime conceived and developed the intricate material structure of civilization and lavishly supplied the human race with the marvels of the present mechanical age in all their myriad forms, has marshaled its mighty forces to the task of producing armament.

Mining, metallurgy, power, communication, manufacture, transportation, now united in a common cause, are working in heretofore undreamed of coördination. Manufacturing units in automotive, aeronautical, marine, radio, textile, chemical, machine-tool, foundry, petroleum, and scores of other widely diversified fields are one in the all-out effort. Peacetime boundaries and selfish interests forgotten, this whole vast edifice of variegated parts and divergent aims has fused overnight into a single concentrated operation. Skyrocketing production figures have already begun to look like a mathematician's field day.

Here, as on the battlefield, the pace is also set by machines—small hand tools that multiply the effect of labor; massive machine tools that quickly accomplish work which man unassisted could never duplicate; cranes and hoists with the strength of many men; lathes, forges, presses, turbines, compressors—machines in endless variety all veritable miracles of mechanical and engineering ingenuity.

In this phase of modern warfare there are no medals or citations,* no headlines. The goal is construction, not destruction, and blitzkrieg is mass production.

It is upon the accomplishments of the industrial front that ultimate victory depends—a victory that must be as complete as it is inevitable, awaiting only the time when our forces on the battlefront have the war implements which we, more than any nation in the world, are equipped to supply.

*The Navy does award the Navy "E" for excellence in production.

Producing Pig Iron for the Trade

W. H. O'Connell

BLAST FURNACE AND SINTERING MACHINE

The picture at the top, center, shows the stack of the furnace. The inclined structure on its left is a skip hoist by which cars of ore, limestone, and coke are elevated and charged into the top through a double bell and hopper designed to prevent escape of the gases. The latter are exhausted through two offtake pipes, one of which appears at the right. Immediately above is the sintering machine. Crushed, concentrated magnetite ore, with which 5 per cent of carbonaceous material is mixed, is spread on an endless chain grate and ignited by a gas torch, as shown here. A downdraft through the mixture is induced by suction, and the carbon burns from the top downward. By the time the grate has traveled to the end sprockets, the fine iron ore has been consolidated into a spongy mass that breaks up and falls through a chute into a car for haulage to the blast furnace.

THE term blast furnace is a symbol for iron and steel production in the minds of most persons, and that is quite correct. Today, practically all iron is made in the blast furnace into which the raw materials—iron ore, limestone, coke, and air—are charged and from which, after reacting, they emerge as molten pig iron and slag, as well as gas. Possibly one reason for the significance attached to the blast furnace is its physical dominance over nearly everything else in its vicinity.

Girded with heavy riveted plate, reaching as high as 100 feet above ground level, a modern blast furnace appears to be and is the point of convergence of a multitude of pipe lines, conveyors, and flues. Such a furnace has been operated for a number of years by the E. & G. Brooke Iron Company of Birdsboro, Pa. It was built for a nominal output of 350 tons of pig iron per day, and, while not in the size classification of some large steel-plant units which produce 1,200 or more tons in the same interval, its daily consumption of ore, coke, limestone, and air is, to say the least, impressive. It runs to something like 1,200,000 pounds of ore, 650,000 pounds of coke, 350,000 pounds of limestone, and 2,750,000 pounds of air. Moreover, in a day's time, there is circulated in the plant for cooling purposes about 4,500,000 gallons of water.

The Brooke furnace is designed along conventional lines. Within its steel shell is a lining of firebrick which protects the shell from both heat and the erosive action of the materials which pass through it. Iron ore, coke, and limestone are introduced in rotating charges through a double bell and hopper at the top-platform level. Unlike the foundry cupola, wherein complete combustion is sought, the blast furnace depends upon the incomplete combustion of coke to produce carbon

monoxide to serve as a reducing agent throughout the stack. Some of this carbon monoxide is converted into carbon dioxide at the time it performs the primary function of reducing the iron-bearing portion of the ore (usually magnetite, Fe_3O_4, or hematite, Fe_2O_3) into metallic iron. The complete reaction is usually expressed chemically by the formula $Fe_2O_3 + 3CO = 2Fe + 3CO_2$.

For every cubic foot of carbon monoxide converted into carbon dioxide in this way and at this coke rate approximately 2 cubic feet of monoxide will pass out of the furnace unchanged. This unused gas, together with a small percentage of hydrogen gas, is too valuable a fuel to be wasted. This explains the gastight double bell at the top of the furnace and the extensive array of dust catchers, gas scrubbers, water separators, etc., that are part and parcel of blast-furnace equipment.

Blast-furnace gas is valuable when one considers its many applications throughout the plant. It heats the brick checkerwork of the stoves which, in turn, heat the blast air coming from the blower; and it helps to heat the boilers generating steam for the furnace blower and, directly or through electrical conversion, the pumps, conveyors, and other power-driven units. If the volume of gas is insufficient, auxiliary fuel in the form of coal is fed to the boilers. At the Brooke plant, the flue dust caught in the dust catcher also is used to good advantage in a sintering plant.

Few persons know that the term pig iron is derived from the older method of producing iron in solid form. In the early days a furnace was tapped when a quantity of molten iron had collected in the hearth at the bottom, the metal being carried away in a trough dug in the sand

CASTING IRON PIGS

Once every four hours the furnace is tapped and the molten metal is drawn off at the iron notch (above) while the slag is drawn off at the cinder notch on the far side of the furnace. The stream of metal, containing some slag, flows to a dam and skimmer. There the slag, having risen to the surface, is skimmed off and diverted through the upper channel. The iron empties into a ladle by way of the lower channel and is poured into the moving molds of a continuous pig-casting machine, as seen at the left.

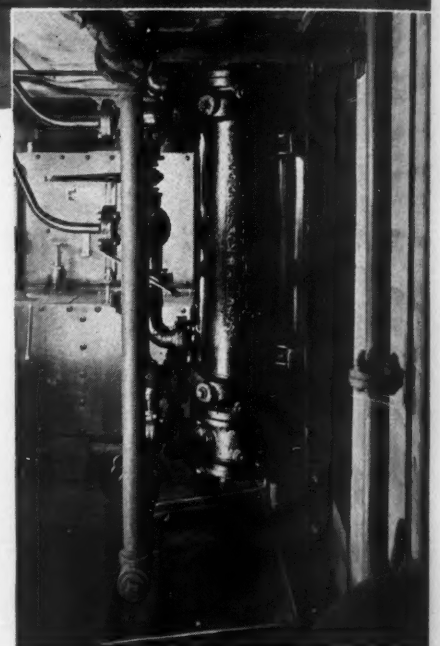
of the tapping floor. Branching off at right angles from the main trough were a series of laterals called sows, and each of these fed into still another series of closely spaced smaller pockets called pigs, each holding about 100 pounds. Hence the term pig iron. The sand-casting bed has given way to the pig machine in which the metal is formed in molds slung between moving chains.

One major distinction between the Brooke Iron Company operations and those of most blast furnaces in the United States is that the plant at Birdsboro makes only merchant pig iron, whereas the others generally produce pig iron as a first step in a continuous steel-making process. The term merchant furnace is applied to those that make pig iron only for marketing. Operating a merchant furnace injects problems which differ from those confronting the steel-plant blast furnace. In the case of the latter, considerable uniformity in output is maintained from month to month and year to year. This means that various temperature zones within the furnace remain constant for protracted periods of time, a fact that is conducive to long furnace-lining life which, in turn, makes possible long, continuous service. Runs of five, six, and even seven years of iron production without relining have been recorded for steel-plant blast furnaces.

By contrast, the merchant furnace may make pig iron of one of a wide range of analyses for a few days and then change to another to meet market or customer demands. The effect of this on the furnace lining is easily understood when one knows that changing the burden or product calls for a corresponding change in the melting zone. With these conditions in mind, the fact that the Brooke No. 3 Furnace is now in its fourth year of continuous, full-capacity operation assumes noteworthy porportions.

Many blast furnaces can be made to yield an appreciably larger tonnage of pig iron than the nominal rating of the unit. One way to obtain greater capacity is to prepare the ore for reduction. The magnetite ore that is converted into pig iron in the Brooke furnace comes from the company's Richard Mine in northern New Jersey. Before it is shipped by rail to Birdsboro, every pound of it is crushed and concentrated. As a result, the ore presents to the carbon-monoxide gas in the upper part of the furnace far more contact surfaces than would otherwise be the case, thus speeding up reduction of the magnetite to metallic iron. In practice, however, all concentrated ore cannot be charged into the furnace as such, for the gases forcing their way up and out would carry along with them a high percentage of the fine particles. Moreover, there would be a greater tendency to "pack," and this would lead to excessive blast pressure. To overcome this, a process called sintering is employed to convert the concentrate into spongy chunks which can be satisfactorily fed into the furnace and which, because of their porosity, provide improved gas contact and thus speed reduction.

Sintering is done at Birdsboro. Concentrate arriving from the mine is dumped from railroad cars into a stock bin alongside the sintering plant. The first operation is to add carbon, preferably in the form of flue dust. Since approximately 5 per cent of the material to be sintered must be carbon, and since all the flue dust recovered from the furnace gas will not supply enough carbon to meet requirements, some anthracite culm is used. Mixing of the ore and the carbon is done in a pug mill. The material is moistened during the operation, and the final product is a fluffy mass of glistening particles that is discharged into a hopper over the sintering machine.



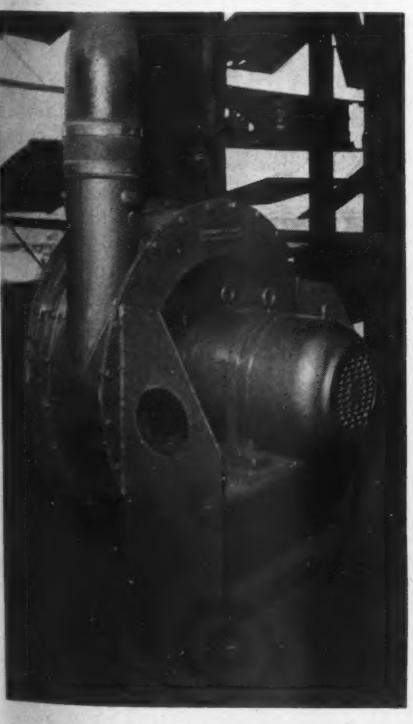
BLAST-FURNACE BLOWER

At the top is the 3,600-hp. unit that furnishes approximately 25,000 cubic feet of air per minute at 12 to 14 pounds pressure for blowing the blast furnace. Since it was started up in 1939 it has operated more than 99 per cent of the time. During that period, it has handled air amounting to 26,000 times its own weight. Oil for the blower and the turbine that drives it is cooled by the twin cooler and strainer at the right in the lower picture and cleaned by the bag-type filter in the background.

The sintering machine is an endless-chain grate about 57 feet long and 3½ feet across. Below it, a powerful fan, 100 inches in diameter, maintains a constant suction or draft down through the grate. Sinter cake, approximately 7 inches deep, is spread evenly on the moving grate, and, as it travels along, the carbon in the

material is ignited by a fixed twin-element torch burning a mixture of blast-furnace gas and air. Immediately beyond the torch the sinter can be seen glowing a dull red and burning at the top. Under the influence of the strong downdraft the carbon content in the upper zone is soon exhausted and that in the one immediately below begins to burn. This procedure continues until, by the time the delivery end of the sintering machine is reached, only the thin layer contiguous to the grate is glowing, the remainder of the material having cooled down to a steely gray color. As the endless grate rolls over the end sprockets the spongy mass breaks up into pieces, tumbles down a chute into a railroad car, and is soon *en route* to the blast furnace.

Sintering at the Brooke plant is paced, so far as possible, to keep up with blast-furnace requirements in order that material handling and storage may be reduced to a minimum. Working on a schedule such as this calls for close coördination of all elements, as well as reliable, trouble-free operation on the part of all the equipment. Prior to this year, the low-pressure air for the ignition torch was supplied by a positive-displacement blower. While this unit had served long and well, it had definitely seen better days, and the management therefore decided to retire it and to use in its place a 15-hp. Ingersoll-Rand



COMBUSTION-AIR BLOWER

This 15-hp., 2-stage unit supplies air during the sintering process to the gas-burning torch that ignites the carbon mixed with the ore. This type of machine produces a steady flow of air free from pulsations and is equipped with a blast gate that permits close control of the volume of air delivered. These two factors result in more perfect combustion at the torch.

2-stage centrifugal Type G Motorblower.

Because the logical location of the blower is in the sintering room where the air is unavoidably dusty at times, the unit was equipped with a totally inclosed fan-cooled motor. The intake air is drawn from outside the building, and the discharge is piped directly to an overhead air-and-gas-mixing header leading to the torch. Because the new blower is a variable-volume, constant-pressure machine it has inherent advantages over the previous installation, and these were apparent as soon as it was put in service. Foremost was the absence of pulsations in the discharge air. Pulsations are a characteristic of positive-pressure blowers and had been responsible for some of the annoying torch failures.

In the matter of power consumption, the centrifugal blower is also superior to constant-speed positive-displacement equipment because the former uses power only in proportion to the volume of air delivered while the latter can make the necessary adjustments in the volume of air supplied only by wasting the excess air compressed. Lastly, the operators of the Brooke sintering plant have found that the smooth air flow and the exact volume settings possible with blast-gate control enable them to obtain more perfect combustion in the torch. This results in a generally hotter flame and in economies in the use of gas.

Sintering may be one of the less spectacular sides of steel-plant operations, yet it serves to increase the otherwise fixed output of a blast furnace. A recent analysis of the subject in *Steel* urges iron and steel producers throughout the country to give it renewed consideration, especially those that do not make it a practice to use an appreciable proportion of sinter in the charge. A boost of 10 to 19 per cent in output can be secured in this manner at a much lower cost and with but a fraction of the critical materials than by setting up new blast-furnace equipment capable of producing the same quantity of pig iron.

Another of the routine functions vital to the operation of a furnace is that of supplying it with air. In the case of the Brooke company, about 25,000 cubic feet of air at 12 to 14 pounds pressure is needed every minute of the day and night. In the figures given at the beginning of this article it will be noted that air is the heaviest single item in the "daily diet" of the Brooke furnace. It is supplied by a 3,600-hp. Ingersoll-Rand turboblower direct connected to a 3,600-rpm. condensing steam turbine. The unit was installed late in 1930.

Blower and turbine must take "time out" at regular intervals to make the necessary insurance checks of their condition, as is required in the case of such high-speed centrifugal machinery. To provide for this, the old steam-driven blower that formerly furnished the air is maintained in working order by the company. Following is a record of the "time out" for the main blower and of the "time in" for the old one for approximately three years:

1939–	99 hours, starting June 6
1939–	12 hours, August 19
1940–	20 hours, starting September 23
1941–	8 hours, March 31
1942–	3 hours, February 26
1942–	96 hours, starting March 30
	238 hours

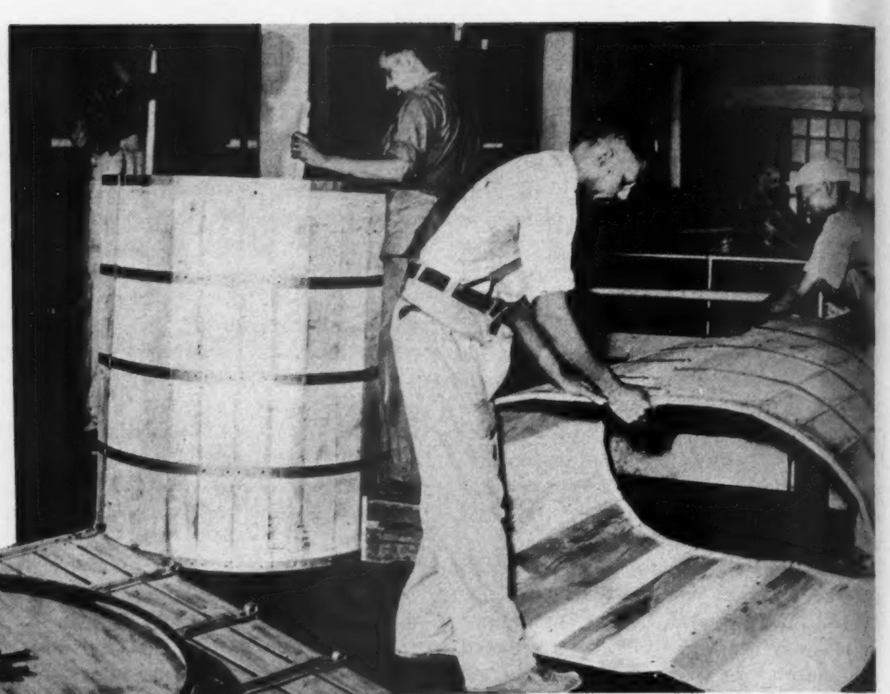
From April 1, 1939, until the time this article was prepared, the Ingersoll-Rand blower has piled up a total of 27,532 operating hours out of a possible 27,770. This represents a service factor of more than 99 per cent. In this period it has handled in excess of 3,000,000,000 pounds of air—26,000 times its own weight, or three times the weight of the pig iron produced. Turboblowers of this type are ideal machines for such long continuous runs, for neither the turbine nor the blower embodies parts with rubbing surfaces other than in the bearings. The latter have conventional babbitted shells of generous size augmented by Kingsbury thrust bearings at one end of each machine. All bearings are force-feed lubricated with oil from a positive-pressure pump driven by the turbine rotor. Before being delivered to the bearings, however, the lubricant is cooled; and some of the oil is always in process of being cleaned by a twin-element, bag-type filter.

As might be expected, the quality and reconditioning of the oil for the turboblower are major considerations of the operating personnel of the blower room. Carefully recorded data show that highly satisfactory lubrication can be assured at reasonable expense with a properly functioning oil system. At the start of the present run in April, 1939, the lubricating system and oil reservoir were filled with 200 gallons of good-quality oil. About 12 gallons of make-up oil are required each month, so an amount equal to the original supply is added every 16-17 months. Meanwhile, the filter removes impurities from the lubricant, and samples are taken at the end of each month and carefully tested. While the blower was shut down in March of this year all the oil was drawn from the system, and the reservoir and piping were thoroughly cleaned and flushed. The 200 gallons were found to be in good condition, so the entire supply was filtered and put back. Only three quarts of water were removed in the process.

Assuming a minimum 4-year run with the original 200 gallons, plus 576 gallons of replacement oil, a total of 776 gallons will be consumed in the 48-month period. At 35 cents a gallon, the cost will be $272, or less than 25 cents a day for lubricating a 3,600-hp. turbine and a 3,600-hp. blower.

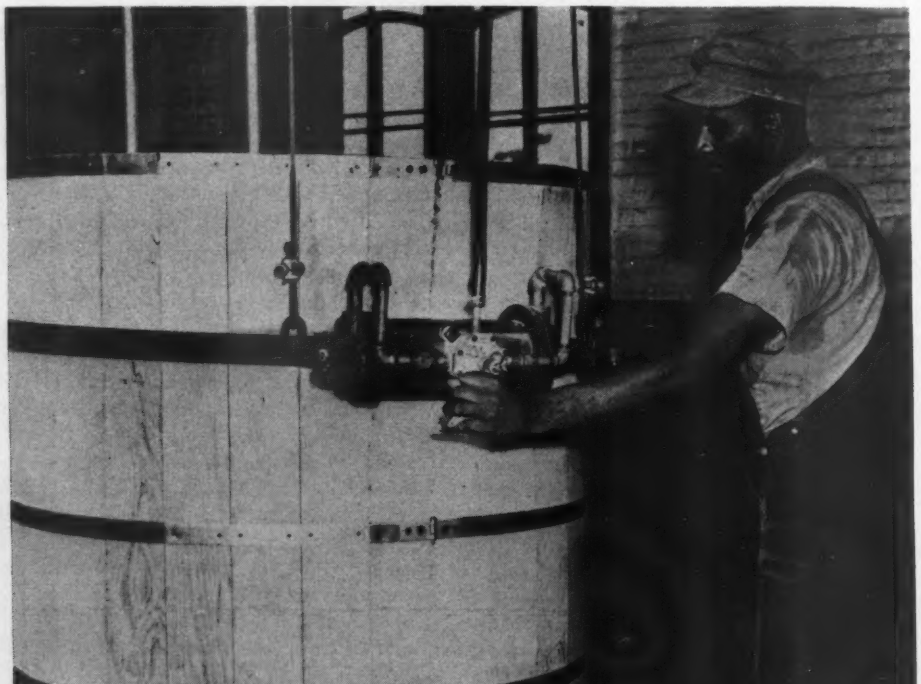
Cooper Stages a Comeback

A. M. Hoffmann



ASSEMBLY

At the left is a knocked-down barrel with hardware showing the prefabricated mats. In the case of hogsheads 54 inches long and 46 inches in diameter, 200 sides occupy a space 36 feet square and $8^1/_3$ feet high. In the picture at the top the men in the foreground are lining up the ends preparatory to inserting the locking pins, while the workers at the left are pounding the bottom in an upended container with wooden headsticks.



FINISHING OPERATION

After the packed container has received its head by opening the three uppermost hinges on one side to give the top the necessary spread, the hogshead is pulled together for replacement of the cotter pins by the air-operated ratchet shown here. The device is suspended to facilitate handling.

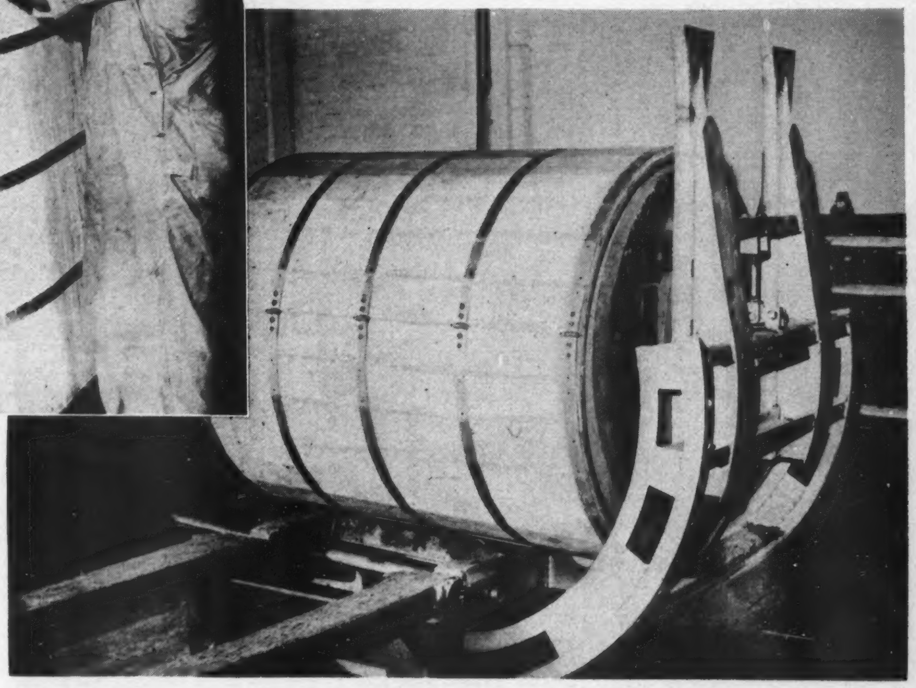
PRIORITIES have clamped down on the use of steel drums for other than the most essential services, according to a recent announcement made by the War Production Board. Plants, especially those handling bulk commodities, will have to look to the cooper to supply them with substitute containers, and the indications are that he will be busy once again rolling out barrels and hogsheads. But like every other more or less back number that is being taken off the shelf and restored to general use because of need, the wooden barrel is being modernized, and in its latest form is a big improvement upon the bulging type with which we are familiar.

One of the containers that may pinch-hit for the steel drum is made by the Planters Manufacturing Company and is a direct result of the plywood industry. It is a prefabricated, collapsible barrel that saves shipping and storage space, that is easy to assemble and to knock down, and that is of sturdy construction to permit reuse. It was originally designed for packing and transporting tobacco, but is now being built to specifications for any bulk material that can be handled in that way.

The sides and heads of the container are made of Southern hardwood or Douglas fir plywood. The staves are assembled at the coopery in the form of interchange-

IN THE TOBACCO INDUSTRY

Below is shown the cradle used by the Liggett & Myers Tobacco Company to upend hogsheads of tobacco arriving at the factory from the warehouse where they are stored for about two years to age the leaf. Each is set on a movable base, as seen at the left, and opened simply by withdrawing five of the ten hinge pins. The sides and heads are then inspected by coopers, who do the necessary repairs before the parts are stored flat for reuse.



able mats of which two or more are required for one barrel. They are locked together by the user simply by inserting cotter pins in hinges at the ends of metal straps to which the staves are fastened. The heads also are interchangeable and are provided with a circular band of oak to protect the staves against breakage when the container is upended. This band fits snugly against reinforcing strips or liners of plywood nailed top and bottom inside the staves.

The standard hogshead for packing tobacco has a capacity of 1,000 pounds and is made of 3-ply Douglas-fir plywood. It is assembled by laying two mats, each of fifteen staves, flat on the floor and connecting them as already described by means of the locking pins. After the ends have been brought together and similarly joined, the barrel is set upright and the bottom is dropped in and hammered to a tight fit against the liner. When filled and ready to receive the head, the three uppermost cotter pins on one side are removed. This allows the container to spread sufficiently to permit slipping the top into position with little pressure. The final operation involves the use of an air-operated ratchet which pulls the barrel together so that the pins can be replaced in the hoop hinges.

From the standpoint of economy, hogsheads of this description not only weigh much less than those that were previously used for the purpose but they also have a considerably longer service life. It is claimed that with proper care and maintenance, they are good for from 50 to 75 round trips each. Because of their structural get-up they can be packed and unpacked without damage because there are no nails to be driven and pulled. At the plant of the Liggett & Myers Tobacco Company these containers serve to store leaf tobacco for cigars and cigarettes for aging. They remain in the warehouse for about two years, and when they are rolled out and into the factory on a runway, each is upended by a cradle on to a circular platform mounted on rollers. To open it, it is necessary only to unlock five hinges, thus permitting the removal of the head and sides, the latter in one piece, leaving the bottom under the compacted tobacco for the time being. Before it is used again, the knocked-down hogshead goes to the maintenance shop where the parts are checked, carefully inspected, and broken or otherwise damaged staves, liners, bands, heads, and metalwork are repaired or renewed.

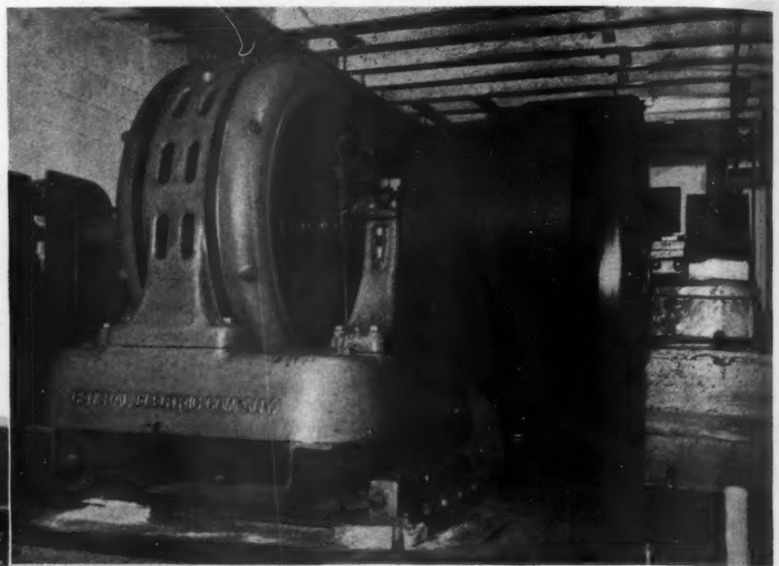
Mass Production of Templates by Photography

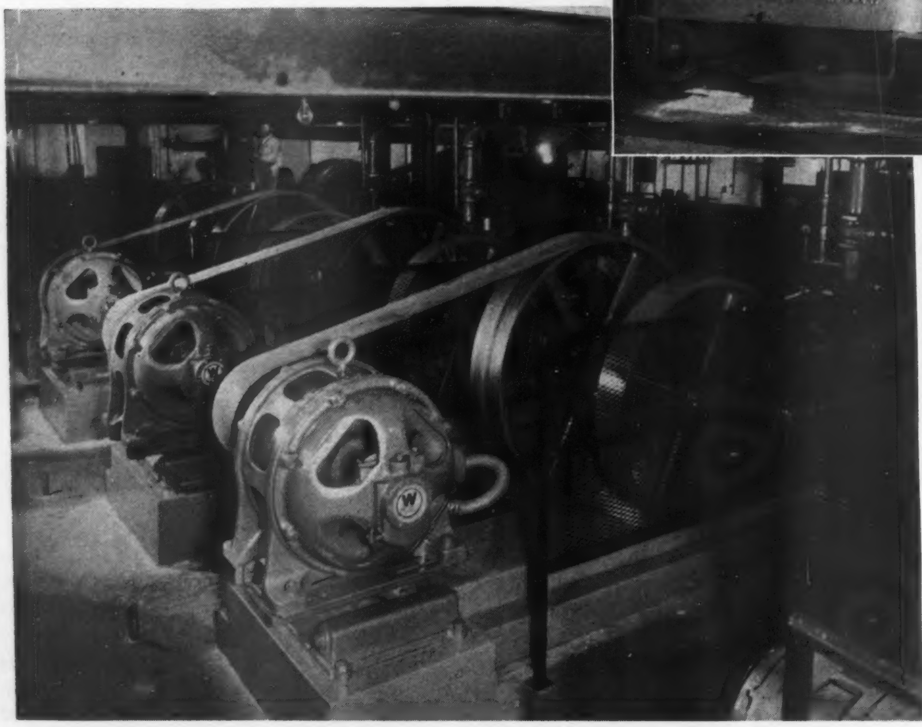
PHOTOGRAPHY has broken a bottleneck in the airplane industry and is doing the work of the layoutman and the mold loft where drawings of construction details of planes originating in the drafting room are reproduced full scale on big sheets of plywood or metal to serve as working drawings or templates. The loft floor is actually a huge drawing board on which the men have to do all the necessary work on their knees, and is a survival of the days of our famed New England clipper ships. It was taken over by the airplane industry and met all requirements until war demands stepped up production to such an extent that all the lofts in the country could not begin to supply the multiple templates for the many scattered plants that are assisting airplane builders by manufacturing parts or subassemblies for fighters and bombers.

By the new method, which was acquired from the maker of precision patterns, the full-scale drawing is made on a sheet treated with phosphorescent chemicals which give off a blue light after bombardment with X-rays. The metal that is to serve as the working drawing or template is coated with a cellulose-nitrate lacquer and is then faced under red light with photosensitive film. The latter, having a nitrate skin, is fastened to the surface by nitrate cement and the pressure of rubber rollers. Transfer of the image is made by placing the phosphorescent drawing in contact with the photosensitive metal, which next goes successively through the developer, stop bath, hypo, and wash tank. By means of glass plates it is possible to make a positive and a negative of the resultant print to serve as right and left templates. After checking closely for precision, the metal photographs are cut into as many templates as the drawing specifies. It is claimed that they are held to tolerances as close as 1/1,000 of an inch per foot and that as many as 250 hours of checking time are eliminated in the production of a set of templates from one drawing.

Making Belts Last Longer

*J. R. Hopkins**





AUTOMATIC BELT-TIGHTENING MOTOR BASES

Above are shown three Ingersoll-Rand air compressors driven through flat belts by motors set on Rockwood bases which automatically maintain belt tension. At the top is an end view of such a base, which pivots to facilitate putting the belt over the pulley.

NOW that the shortage of certain materials is more a reality than a threat, it behooves us all to protect existing equipment and to lengthen its life wherever possible. Though belting is admittedly not as "critical" a material as many others, nevertheless it plays a major part in industry and should always be treated with care. If due precautions are taken, the service life of your belting will be increased and the efficiency curve of your belt-driven machines will rise considerably.

There are a few simple rules which, if followed regularly, can do much to bring about these conditions. The most important of these are as follows: Keep leather belting properly cleaned and dressed. To clean a belt, wipe off the dirt with waste that has been dipped in gasoline, naphtha, or carbon tetrachloride. After it has dried, apply a dressing of good quality. The purpose of the latter is to keep the fibers from drying out. Ordinarily, it is necessary to use dressing once every three months; but in plants where the air is very dry or dusty, or where belts are overloaded, that may have to be done every month or possibly every week.

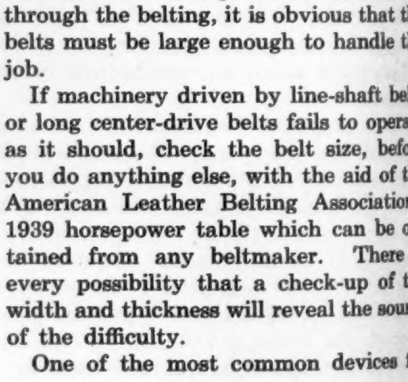
Make sure that your leather belts are of the endless type. It is commonly conceded that such belts (the lapped type as distinguished from those held together by metal fasteners) are the most durable. Metal fasteners constitute the weakest part of a belt; and a belt, like a chain, is no stronger than its weakest link.

Be certain that the thickness of your belting is correct in relation to the diameters of the pulleys. There are minimum pulley diameters for leather belts of different thicknesses. It is recommended that the figures in the accompanying Table A be adhered to strictly.

Check your belting for size. In other words, do not use too small a belt for the load involved. If belt-driven machines are to operate properly, it is imperative that they be supplied with sufficient continuous power to handle all peak loads no matter how frequent or severe the loads may be. To accomplish this, means must be provided for conveying the full power of the motors or the line shafts to the machines. Since this power is transmitted through the belting, it is obvious that the belts must be large enough to handle the job.

If machinery driven by line-shaft belts or long center-drive belts fails to operate as it should, check the belt size, before you do anything else, with the aid of the American Leather Belting Association's 1939 horsepower table which can be obtained from any beltmaker. There is every possibility that a check-up of the width and thickness will reveal the source of the difficulty.

One of the most common devices for



V-BELT MISALIGNMENT

If a multiple V-belt drive is out of alignment, the ropes will scrape down one side of the grooves where they enter the driven pulley and will scrape down the other side of the grooves where they enter the driver. Such constant scraping greatly reduces belt life, and the drive should be realigned at once.

*Engineering Department, Chicago Belting Company

	SINGLE PLY		DOUBLE PLY			TRIPLE PLY	
	Med.	Heavy	Light	Med.	Heavy	Med.	Heavy
Belts Under 8" Wide	3"	5"	6"	8"	12"		
Belts 8" and Wider			8"	10"	14"	24"	30"

TABLE A

Much belt trouble can result from using pulleys that are too small for belts of given thicknesses.

power transmission is the short-center leather-belt drive from an electric motor or a gas engine. This type is highly efficient when used with an automatic belt-tightening motor base. Generally speaking, an arrangement of this sort gives little trouble and requires a minimum of drive maintenance. It is important, however, that the pulleys be large enough to keep up belt speeds. Doubling the belt speed doubles the horsepower a belt will transmit, or cuts in half the belt stress for the same horsepower. Make certain that the diameters of your motor pulleys are the same as those recommended by the motor manufacturers. Pulleys that are too small greatly lower the efficiency of short-belt drives. If short-belt drives are used in your plant, you will find that the *Short Center Leather Belt Drive Data Book* is very helpful. A copy of it can be procured from the firm that manufactures your belting.

Another common device for power transmission is the V-belt drive. As its name suggests, the cross section of this belting tapers sharply from top to bottom, forming a wedge-shaped trapezoid. In general, V-belt drives are found in multiple arrangements; that is, several belts and several pulleys operate side by side in parallel planes. For best results with this type it is urged that the following suggestions be observed:

When designing new installations plan on larger sheaves and also on the use of one or two more belts than the minimum recommended. The extra cost is offset by the longer service life of the equipment.

Be sure that the sheaves are properly aligned in both the horizontal and the vertical plane. Attention to this detail will help to prolong belt life.

Purchase matched sets of belts so that each will carry its full share of the load.

Don't force or pry belts over the sides of the grooves. Before putting them in place, slide the motor forward; then, when the belts are in position, slide the motor back until they are under the required tension. Or, use a pivoted motor base. With this type of base the belts will go on easily, and the tension under load will always be correct.

Keep V-belts tight. If not equipped with a pivoted base, check the tension 36 hours after the belts are installed and at frequent intervals thereafter. When struck with the hand, properly adjusted belts should respond with a live, springy vibration.

Keep V-belts clean—free of dirt, grease, and oil. Simply wipe with waste that has been dipped in gasoline. No dressing is necessary.

Check sheave grooves to make certain that they are smooth and not worn out of shape. If the sheaves are worn, replace them with new ones.

Never renew just one V-belt of a set; get a whole new set. The old one will serve as a spare.

Frame No.	3600 RPM	1800 RPM	1200 RPM	900 RPM	720 RPM	600 RPM	Standard Pulley		
							Dia.	Face	Bore
203 204	1-1½	¾ 1	½ ¾-1	½			3 3	3 3	¾ ¾
224 225	2-3	1½ 2	1½	¾ 1	½		4 4	3½ 3½	1 1
225 254	5	3	2	1½	¾ 1	½ ¾	4 4½	3½ 4½	1 1⅛
254 284	7½ 10	5 7½	3 5	2 3	1-1½ 2	¾ 1½	4½ 5	4½ 4½	1⅛ 1¼
324 324	15	10	7½	5	3	2	5 6	6¾ 5½	1⅝ 1⅝
325 326	20	15	10	7½	5	3	5 8	6¾ 6¾	1⅝ 1⅝
364 365		20	15	10			9 9	7¾ 7¾	1⅞ 1⅞
365 404		25	20	15	7½ 10	5 7½	9 10	7¾ 7¾	1⅞ 2⅛
405 405		30	25	20	15	10	10 10	7¾ 7¾	2⅛ 2⅛
444 444		40	30	25	20	15	11 11	9¾ 9¾	2⅜ 2⅜
445 504			40 50	30 40	25 30	20 25	11 12	9¾ 11	2⅜ 2⅝
505 505			60	50	40	30	14 14	13 13	2⅞ 2⅞

TABLE B

The National Electric Manufacturers Association recommends the pulleys listed here as the smallest that should be used with the motors specified for all-around good results. All pulleys are of standard size.

Pulley Diam. Inches	SPEED OF PULLEY—R.P.M.							
	3450	1750	1150	850	690	575	490	435
1½ 2	1354 1805	687 916	602		BELT SPEED F. P. M.			
2½ 3	2257 2708	1145 1374	753 903	667				
3½ 4	3160 3611	1603 1832	1054 1204	779 890	632 721	602		
4½ 5	4062 4514	2062 2291	1355 1505	1001 1113	810 902	677 752	642	
5½ 6	4965 5417	2520 2749	1656 1806	1224 1335	992 1082	828 903	706 770	684
6½ 7	5868 6319	2978 3207	1957 2107	1447 1558	1171 1261	978 1054	834 899	741 798
7½ 8	6771 7222	3436 3665	2258 2408	1669 1780	1351 1441	1129 1204	963 1027	855 912
8½ 9	7674 8125	3894 4124	2559 2709	1892 2003	1532 1622	1279 1355	1091 1155	969 1026
9½ 10		4353 4582	2860 3010	2114 2225	1715 1806	1430 1505	1220 1284	1083 1140
10½ 11		4811 5040	3161 3311	2337 2448	1897 1987	1580 1656	1348 1412	1197 1254
12 12½		5498 5727	3612 3763	2670 2782	2161 2256	1806 1881	1541 1605	1366 1425
13 13½		5956 6185	3913 4064	2893 3004	2342 2435	1957 2032	1669 1733	1482 1539
14 14½		6414 6644	4214 4365	3115 3227	2522 2617	2107 2182	1797 1862	1596 1653
15 15½		6873 7102	4515 4666	3338 3449	2705 2800	2258 2333	1926 1990	1710 1767
16 16½		7331 7560	4816 4967	3560 3672	2882 2973	2408 2484	2054 2118	1824 1881
17 17½		7789 8018	5117 5268	3783 3895	3062 3156	2559 2634	2182 2247	1937 1994
18 18½			5418 5569	4006 4117	3240 3338	2710 2785	2311 2375	2051 2106
19 19½			5719 5870	4228 4340	3422 3518	2860 2935	2439 2503	2165 2222
20 21			6020 6321	4451 4673	3605 3793	3011 3161	2568 2696	2279 2393
22 23			6622 6923	4896 5118	3965 4150	3312 3462	2824 2953	2507 2621
24			7224	5341	4330	3613	3081	2735

TABLE C

Recommended belt speeds in feet per minute for different pulley diameters and revolutions per minute. Experience shows that the cheapest and most satisfactory belt drives are those with belt speeds of 3,500 to 4,500 feet per minute. Within this range can be used narrower belts and pulleys, lower bearing pressure is required, and belts will last longer. On the whole, the operating results obtained are generally more satisfactory.

How to Get the Best Results with Electron Microscopes

SCIENTISTS of the General Electric Company have found that plastic films five-hundred thousandth of an inch thick are best for revealing details of metal surfaces under the electron microscope. Instruments of this type magnify the details as much as 20,000 times, which is far greater than the useful limit of the ordinary optical microscope, and have already brought to light important knowledge concerning various metals used for war purposes.

The technique by which the films are made was perfected by Vincent J. Schaefer and Dr. David Harker of the General Electric Research Laboratory, and is basically the same as one that Mr. Schaefer developed as a hobby to preserve snowflakes and frost patterns. It involves polishing the sample and etching it for a few seconds with acid before dipping it in a solution of Formvar—a plastic—in dioxane, a commercial solvent. The interval between drying after etching and dipping must be short—not more than a few minutes, otherwise an infinitesimally thin film of grease or other contaminating material may start to form and affect the results. After immersion, the solvent in the Formvar solution evaporates, leaving the plastic film which reproduces the microscopic hills and valleys of the metallic crystals. When stripped off, the film can be placed in the electron microscope for examination.

The scientists have discovered that the success of the method depends on the thickness of the film, which can be regulated by the strength of the solution. In the case of very thin ones—approximately one-millionth of an inch—the contrast in the final electron picture is not very great. The reason for this is that the contours of the hills and valleys of the metal are outlined on both sides of the film, making nearly all the material equally transparent to the electron beam. The best thickness for satisfactory electron micrographs is around five-hundred thousandth of an inch. Then the top of the film remains level and the hills and valleys are impressed only on the bottom.

Air Motor Drives Model Airplane

MODEL PLANE AND MOTOR

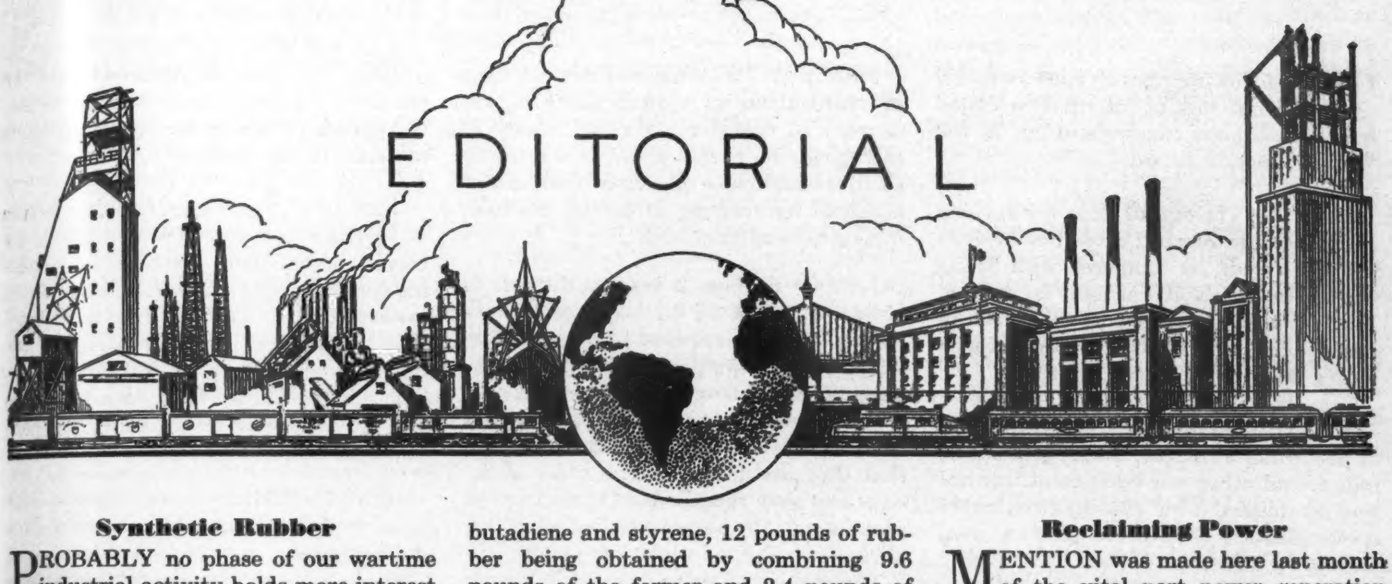
This English-built model weighs only slightly more than half a pound, complete, and is driven by compressed air at an initial pressure of 150 pounds per square inch. This is fed to the engine from the wire-wound body of brass and copper foil that serves as an air receiver. The engine is shown separately at the right, with an English half crown alongside to give an idea of size. The coin is $1\frac{1}{4}$ inches high. The engine weighs only $\frac{5}{8}$ ounce.

THE flying of model airplanes as a hobby or sport has gained considerable popularity, especially among the younger generation. The less expensive craft utilize an "elastic engine" in which the driving impulse comes from the untwisting of a rubber band. These are fairly successful and have been known to make flights of several minutes' duration. Although they bear little resemblance to the motors of full-size planes, they are the easiest type to construct and give the modeler satisfaction because they fulfill their intended function. More ardent enthusiasts, or those that have greater financial means at their command, go in for more orthodox power plants. These ordinarily take the form of miniature gasoline engines which burn a thimbleful or less of gasoline during a flight.

Illustrated on this page is a beautiful model of a monoplane, together with the compressed-air motor that propels it. It is the work of an English modelist who built it to gain experience before constructing more elaborate craft powered by single- and twin-cylinder gasoline engines. The total weight of the monoplane including the motor is $10\frac{1}{2}$ ounces, and its over-all dimensions are: wing span, 45 inches; length, 25 inches; height, $8\frac{1}{2}$ inches. The body or fuselage, which serves as the air receiver, is made of brass foil 0.005 inch thick and is reinforced by winding it helically with plated musical-instrument wire spaced $\frac{3}{16}$ inch between turns. It has hemispherical ends spun from copper foil 0.018 inch thick. The "tank" was intended for a working pressure of 150 pounds per square inch, but was tested up to a maximum of 170 pounds. The weight of the complete container is $4\frac{3}{4}$ ounces.

The engine is of the radial type with three cylinders, each with a bore of $\frac{5}{16}$ inch and a stroke of $\frac{11}{32}$ inch. It has a ball-bearing thrust race using balls having a diameter of $\frac{1}{32}$ inch. The cylinder walls are 0.012 inch thick. Pistons are of duralumin and are fitted with cup-leather washers. Connecting rods are of steel with phosphor-bronze bushings on their large ends. The valve is of the rotary distributor type with a ground fit. The weight of the engine, complete with air cock, is $\frac{5}{8}$-ounce. The air reservoir is pumped up with a 3-stage hand pump fitted with a gauge to permit pressure readings. After each rise of 25 pounds, pumping is stopped for a few seconds to enable the metal to adjust itself to the strain. If a fuselage of this construction is properly made it will safely withstand pressures up to 200 pounds. The strength, of course, results from the wire reinforcing.

The monoplane shown has made many successful flights without damage to any part of it. The average duration of a flight is between 50-60 seconds, and in calm air a speed of 23 to 25 miles per hour is attained.



Synthetic Rubber

PROBABLY no phase of our wartime industrial activity holds more interest for the average citizen than that of producing substitutes for natural rubber, for upon the success of those efforts largely depends the use most of us will make of our automobiles during the remainder of the war. There has been much confusion as regards the synthetic-rubber situation, and only in recent weeks has there been any clear-cut explanation by the Government of the plans that are underway.

Out of the welter of claims and discussions, these facts have emerged: Of the various rubber substitutes that can be made, the one known as Buna S. is the most suitable for automobile tires and, consequently, is the one favored by the Government. So-called butyl rubber also shows promise of supplying tires approximately half as good as those of natural rubber. Another kind, thiokol, will provide retreads for tires that will give 5,000 to 10,000 miles of service. Two oil-resistant rubbers, neoprene and Buna M., can be used for making many industrial materials, but they are not suitable for tires.

According to Jesse Jones, Secretary of Commerce, Government-sponsored synthetic-rubber plants having an ultimate yearly capacity considerably greater than our prewar consumption of natural rubber are being constructed and will be in full operation by the end of 1943. Of their output, about 87 per cent will be of the Buna S. type, 8 per cent will be butyl rubber, and 5 per cent will be neoprene. In addition, private industry is producing a sizable annual tonnage of synthetic rubber, and plant capacities are being enlarged. The du Pont interests have long been manufacturing neoprene, and the Dow Chemical Company just put into operation a factory for making several hundred tons of thiokol a year.

In setting up its production facilities, the Government has had to choose among the various processes by which Buna S. rubber is made. The basic ingredients are butadiene and styrene, 12 pounds of rubber being obtained by combining 9.6 pounds of the former and 2.4 pounds of the latter. Butadiene can be derived from petroleum, from grain alcohol, or from coal and limestone. Factors influencing the choice are cost of production and of erecting plants, time required to construct them, and the quantity of critical war materials needed for the purpose. In considering these matters the Government has had the advice of a group of technical experts headed by Charles F. Kettering of the General Motors Company research laboratories, and has elected to obtain most of the butadiene from petroleum. The styrene is derived from coal and is being produced by various chemical companies. All told, 41 concerns are coöperating with the Government in the synthetic rubber campaign.

Regardless of the kind of rubber made, its processing into tires and other essential products will be handled almost entirely by the established rubber companies. The production of synthetic rubber, plus natural rubber from South America and from guayule in this country and Mexico, plus rubber reclaimed from scrap, will most likely meet all our war needs, including lend-lease requirements, and there is hope that there will be a surplus for civilian uses by 1944.

Meanwhile, research in the field of artificial rubber is being pushed, and there is a possibility that new discoveries and improved methods will result in giving motorists a pleasant surprise. At Yale University, 119 men, many of them Ph.D.'s and graduate engineers, are taking a course in rubber technology. Their teachers are experts from commercial organizations. No visitors are allowed, and enrollment is limited to employees of rubber companies whose loyalty is unquestioned. Some of the men who lecture on certain phases of rubber synthesis attend classes to hear experts talk on other phases. The outgrowth of this course may be an ample supply of automobile tires for Sunday motorists of the future.

Reclaiming Power

MENTION was made here last month of the vital part power generation plays in the production of war materials and of some of the ways in which precious kilowatts are being made available. Two recent developments along the same line are worthy of comment. One of them is a method of recovering the power that is used to test airplane engines, and the other concerns natural and processed gas entering into industrial operations.

Unlike automobile engines, which can be broken in by a period of slow driving, airplane engines must be ready to operate at full power from the moment of take-off. This necessitates running them at varying speeds for as many as twelve hours before they leave the factory. During this time the 2,000-hp. power plants of the larger craft consume enormous quantities of high-octane gasoline. Formerly, it served only to whirl a propeller, which furnished the required resistive force. Now the engine on a test stand is coupled to a generator and the electricity produced is fed into the factory power lines. So far, 163 installations of this kind have been made.

Gases that were formerly wasted in various establishments are likewise adding materially to the power output by driving specially designed turbines, some of which develop several thousand horsepower each. In a number of the refineries that turn out aviation-grade gasoline, petroleum vapors pass through catalytic reactors and, in so doing, leave a deposit of carbon on the catalyst that must be removed periodically. This is done by shutting off the flow of petroleum vapor and blowing air through the reactor. The air picks up heat and carbon dioxide, forming a gas that drives a gas turbine coupled to the blower. A similar use of natural gas is made in plants manufacturing carbon black. The gas ordinarily comes from the wells under relatively high pressures which must be reduced before it is utilized. By employing a gas turbine as a reducing valve the energy that was formerly dissipated is put to useful service.

Log of Our War Economy

THE following paragraphs contain significant bits of information culled from official press releases sent out by the War Production Board.

JUNE 26—The output of metal-working machinery has reached a total of $1,400,000,000 a year, as compared with $840,000,000 in 1941, and is steadily increasing. Machine tools, presses, and allied equipment valued at $118,500,000 were shipped during May.

JUNE 27—Because of the growing use of plastics in airplanes, tanks, gas masks, radios, and other war equipment, control was established over the distribution of thermoplastics. All other plastics were previously put under control.

JUNE 29—Restrictions on the sale of safety razors, that were imposed on May 22 to enable the Army and Navy to purchase needed supplies, were rescinded. It is expected that safety razors produced from substitute materials will be available after August 1 to meet all military requirements.

The use of woven, knitted, and braided elastic fabrics was confined to essential health articles and to military products.

It was announced that antifreeze compounds for automobile radiators will be available next winter and at prices lower than some that prevailed toward the end of last winter.

Restrictions on the use of chrome chemicals, especially in the manufacture of pigments and printing inks, were eased by the Director of Industry Operations. The permissible consumption of chrome chemicals in printing inks was raised from 70 per cent of the 1941 consumption to 100 per cent.

JULY 1—The automotive industry is now turning out war goods valued at more than $4,000,000,000 a year. Man-hours worked will be increased by one-third when peak operations are attained and production by more than one-third.

Because cars are being more heavily loaded, less-than-carload shipments of freight required 690,261 fewer railroad cars during the first 25 weeks of 1942 than in the corresponding period of 1941. A 6-ton minimum weight limit per car was put in effect on May 1. It was raised to 8 tons today, and will be further increased to 10 tons on September 1.

Ceilings went into effect on prices charged for hundreds of retail services such as laundering, dry-cleaning, and shoe and automobile repairing. The maximum allowable charges are those that were in force last March. These various services account for an annual retail business aggregating $5,000,000,000.

JULY 2—WPB announced five meetings of railroadmen in various parts of the country to consider ways and means of salvaging critical materials. It is estimated that 8,000 miles of unused rails can be obtained for relaying in camps, arsenals, foundries, and shipyards.

JULY 6—Because it is often difficult to obtain proof of birth, birth certificates will no longer be required of persons seeking jobs in plants where work is being done on secret or confidential Government contracts. Instead, those unable to show certificates will be asked to sign affidavits that they are citizens. The order is designed to save thousands of man-hours of production that have been lost while applicants sought the necessary papers.

The making of spare parts for all types of automotive equipment was restricted and inventories of both manufacturers and distributors were limited. Consumers have to turn in a used part before the new one can be delivered to them.

The labor shortage is so stringent in 138 occupations essential to war production that in some cases there are 94 jobs open for each available trained worker. With 875,000 men scheduled for employment during August, it will be necessary to simplify jobs so that workers can be quickly trained to handle them. Acute shortages exist in the classifications of ship assembler, shipbuilding plate hanger, aircraft skin man, crane rigger, toolmaker, boring-mill operator, tool designer, and many others.

JULY 7—The rebuilding of sewing machines was prohibited and the period during which manufacturers can make spare parts was extended two months.

A regulation covering the sale of materials that are needed for war production but that are now uselessly tied up in plant inventories is expected to release hundreds of millions of dollars worth. It is estimated that 250,000 tons of copper alone will be thus obtained.

JULY 8—The WPB appealed to 20,000 business firms to sell to the Government all the typewriters they can spare. The Army and Navy need 500,000 machines and can get only one-third of them from the manufacturers.

JULY 9—In June, 489,704 tons of steel plate was made in mills that were designed to produce strip and were converted for the heavier type of work. The total plate output for the month was 1,050,000 tons, the greatest on record.

To save critical materials, the construction of elevators has been restricted. Only simple-type, slow-speed units can be built, and doors must be manually operated.

JULY 13—The Government will attempt to purchase the estimated 10,000,000 pounds of Manila cordage in the hands of some 40,000 dealers.

JULY 14—To influence civilians to turn typewriters over to the armed forces, the importance of these machines in furthering actual combat was emphasized. Every message sent or received by a radio operator is typed; every bombing plane carries a typewriter; and, until recent restrictions went into effect, each battleship was provided with 59 machines and each destroyer with seven.

JULY 17—Silk that was woven into cloth prior to June 13 may be used in making church goods, and the production of lures, baits, and flies for fishing may be continued so long as no critical materials other than iron and steel are utilized.

A $5,000,000 loan fund voted by Congress to help college students speed up their training for technical and professional jobs will soon be available. Individual students may receive up to $500 a year at an annual interest rate of 2½ per cent.

Manufacturers of Victory bicycles will be permitted to turn out 100,000 between July 1 and August 31.

JULY 20—A $2,000,000 national advertising campaign to stimulate the flow of scrap metal to war-production plants was inaugurated today.

During the remainder of the year, 5,000,000 additional workers will be employed in the war effort, bringing the total to 17,500,000. Greatly increased employment of women is forecast.

During the week ending July 11, railroads transported to the East coast an average of 788,000 barrels of oil daily. This exceeded the previous high movement by 55,000 barrels.

By restricting the manufacture of cosmetics and toilet articles it is expected that 17,400,000 pounds of chemicals essential to the war effort will be saved annually.

The Office of Defense Transportation issued detailed directions to truck drivers on the care and maintenance of their vehicles so as to make them last longer. The information given is based on experiences in England where trucks and buses are still in operation after three years of war although spare parts are scarcer there than in this country.

Only trucks engaged in services essential to the war effort will be entitled to recapped or new tires after July 26. Typical of trucks affected are privately operated vehicles carrying alcoholic or soft drinks, tobacco products, candy, flowers, toys, furs, radios, or other luxury goods.

Portable Ultraviolet Lamp for the Prospector

THE property of certain minerals to become fluorescent when bathed in ultraviolet light is taken advantage of in mining in various ways. It helps in sorting the ore from the gangue as it comes from the workings, and in the mill it is a quick means of testing the tailings from the jigging and flotation operations. Today, it is also of aid to prospectors in their search for such minerals, one of the most important of which at this time is scheelite, a source of tungsten used principally in the manufacture of high-speed tool steels.

Most of the scheelite found in the United States fluoresces a characteristic blue under properly filtered ultraviolet radiations and can be readily detected by the latter even when it is associated with other ores and gangue material that make identification with the naked eye difficult. To put this phenomenon to use, there has been developed a portable apparatus in the form of a torch consisting of a mercury arc in a bent quartz tube covered by a suitable filter plate. Current is supplied by a rechargeable 6-volt battery—the complete outfit weighing about 20 pounds. For ease of transportation, the battery can be mounted on a board with straps so that it can be packed on the back. The lamp is said to have an effective range of 12 feet throughout an area of 16 square feet and has been used by the Geological Survey of the Union of South Africa to investigate the scheelite occurrences between Kakamas and Goodhouse south of the Orange River.

It is authoritatively reported that tests carried out with the ultraviolet lamp on South African ores have been positive to the utmost degree and that scheelite, when exposed at the surface, becomes apparent even when in its finest powdery form, or in quantities that the assayist would record as a "trace." It has, in fact, already led to the discovery of rich ore that, because of its finely disseminated form, has escaped the keen eye of the prospector for more than six years. Furthermore, examinations of waste dumps—material that has been discarded as not containing sufficient hand-sortable scheelite—have yielded the most spectacular results, in some cases indicating that less than half of the ore was actually recovered by the coarse methods of extraction employed.

Prospecting after dark will reveal scheelite on the surface, whether *in situ* or as float, because weathering has no obscuring effect on its fluorescence. And as the response to the ultraviolet light is instantaneous, large areas can be covered during a night's operations, or a long stretch of a known scheelite-bearing zone can be checked up. As only the mineral will glitter, the prospector has a visual means of estimating the ore right on the spot.

Press That Forms and Stretches Sheet Metal

AMONG the machines that make mass production of airplanes possible is the Erco hydraulic stretching press which is to that industry what the drawing press is to the auto-body builder. It differs from the latter in that the metal is stretched over a form and not pushed through the opening of a die by means of a punch. While it is not offered as a substitute for the drawing press or the power drop hammer, it is better fitted for shaping large and small airplane parts that are open at both ends, such as fuselage and engine coverings, wing tips and tail units, cowling, etc., etc.

STRETCHES SHEET METAL

A 2-cylinder, 300-ton hydraulic press in the plant of the Hudson Motor Car Company showing six of the twelve pneumatic gripper units that open and close the clamping jaws. The machine has a table or platen length of 98 inches and a width of 17 inches and has just finished stretching the skin for the rear fuselage of a Martin bomber. Presses of this type are sometimes operated in tandem, thus doubling the capacity.

The machine is of foreign origin, but in its improved form is the product of the Engineering & Research Corporation. It consists essentially of one or two hydraulic cylinders placed beneath a table or platen between two rows of air-operated clamping jaws. The forms used can be made of cast iron, zinc, or wood, the latter being preferred because it permits alterations of a minor nature to be made with ease. Even concrete with a metal skin has proved practicable for large forms.

In service, the desired form is fastened to the table; the metal sheet is laid on top of it and clamped by the jaws through the medium of gripper units; and pressure of 75, 150, or 300 tons, depending upon the size of the press, is applied by the hydraulic cylinders, thus causing the platen to move upward and stretch the sheet tight over the form. The gripper units are said to be the vital part of the press because, by quickly clamping the material and releasing it when the work is finished, they make quantity production possible.

With the exception of the 1-cylinder, 75-ton press which has six gripper units, the 2-cylinder machines are regularly provided with twelve—six to a side. Each is 16 inches long and is made up of a heavy casting into which is built a pair of special alloy-steel, self-energizing clamping jaws, also 16 inches long, with serrated faces and smoothly ground backs that move against stainless-steel rollers. In each gripper unit are two pneumatic cylinders which open and close the clamping jaws with air at from 90 to 100 pounds pressure. The latter are so constructed that the greater the pull on the metal during the stretching operation the tighter the grip. After the hydraulic pressure is released and the air from the pneumatic cylinders is exhausted, the jaws automatically open. One operating lever engages all the gripper units, but each one is provided with a separate valve. This permits cutting out of the system any number of jaws in stretching material of varying lengths and thus conserving compressed air.

Telephone-Wire Salvage

FROM POLE TO REEL
This mobile winch carries two sets of five detachable reels each and can coil telephone wire of any size at the rate of 10 miles an hour. Note the guide bar mounted on the back platform from which the operator controls the winch.

FOR reclaiming wires from abandoned telephone lines, Gar Wood Industries, Inc., has developed an ingenious reeling system that can coil as many as ten wires simultaneously. The equipment is truck-mounted, and consists principally of a power-driven, worm-geared winch and of demountable reels. The winch is controlled from the rear of the truck by two levers, one for releasing the engine clutch and the other for operating the power take-off. An automatic brake allows free movement of the reels in one direction but prevents backward snap action.

The reels come in units of five, each holding one mile of wire, and are used singly or in sets of two carried on opposite ends of a shaft extending from the winch. They can be easily stripped, one by one, for the removal of the individual coils, which is facilitated by cone-shaped hubs. But before stripping, each coil is tied twice, and again later, and is in condition for immediate reuse. For salvaging small quantities of wire, one 5-reel unit is mounted on the curb side of a utility truck. By this reclaiming system it is possible to reel numerous telephone lines right from the poles in one operation and at the rate of 150 feet a minute.

Concrete-Supported Fiber Casing for Oil Wells

WHAT is said to be the first oil well cased with fiber pipe and concrete is in operation in southern Illinois, and experts believe it is the answer to a problem that is curtailing oil production. Wartime restrictions on steel for the oil industry resulted in the Federal well-spacing order of December 23, 1941, by which drilling is limited to one well every 40 acres. This led the Fibre Conduit Company to experiment with substitute materials not affected by priorities. The product of this work is a casing of wood fiber and pitch which is lowered into the drill hole and serves as a form for the concrete support. The initial installation was made by the Dinsmoor Oil Company under the supervision of the Illinois State Geological Survey, which originated the idea of using fiber pipe. Based on official records for Illinois, which ranks third among the well-producing states in the country, the replacement of steel with fiber pipe would save some 75,000 tons of steel in twelve months if the present rate of drilling were continued. However, if the well-spacing order were rescinded, and drilling reach the 1941 proportions, then a total of 150,000 tons would be saved.

Producing Suction with an Air Blast

IN A FACTORY of the Westinghouse Electric & Manufacturing Company at Cleveland, Ohio, pieces of aluminum up to ¼ inch thick are stamped out in a punch press. Difficulty was experienced in removing the finished work from the lower die without inserting a tool between them. This was undesirable because it harmed the finish of the aluminum and also slowed up production. Vacuum cups were tried, but they proved to be impractical. The problem was solved by blowing compressed air at 80 pounds pressure down through a ¼-inch hole drilled in the upper die. Strangely enough, this causes the upper die to pick up the stamping when the die is raised. When the air is shut off, the stamping falls into the operator's hand. By this means output has been doubled and the number of rejected stampings has been greatly reduced.

This ingenious shop "kink" was among a number of new developments demonstrated before 175 newspaper and trade-journal writers in New York a few weeks ago by Dr. A. A. Bates of the Westinghouse Research Laboratories, the purpose being to disseminate information that might be of use to other concerns engaged in war work. This particular application of compressed air was demonstrated in a very simple way and makes a neat parlor trick. If a pin is put through the center of a piece of cardboard 2x2 inches square, and the pin is inserted in the hole of an ordinary spool, blowing down through the upper end of the spool with the cardboard initially held a fraction of an inch away from the lower surface will serve to keep the disk floating in the air. No amount of blowing will force it away, but as soon as the flow of air ceases, the cardboard drops. The pin is used to prevent the cardboard from slipping sidewise.

The explanation for this phenomenon is found in the fact that the air blown through the spool strikes the cardboard at high velocity and then escapes between the disk and the spool. This serves to create a partial vacuum, and as the air beneath the cardboard is denser than that above it, the disk cannot fall. It is this same principle that makes it possible for an airplane to remain aloft, the shape of the forward part of the wings being such as to induce a partial vacuum on their upper surfaces.

PUTTING THE PRINCIPLE TO WORK
The upper die of a punch press with an aluminum stamping that has been picked up by it by means of compressed air blown down through an orifice in the die. The operator has his hand in position to catch the sheet when the air is shut off.

Industrial Notes

AT WORK
An X-71WD drifter on an FM-2 wagon mounting in an open-pit hematite mine on the Mesabi Range.

Ingersoll-Rand Company has announced an improved drifter, the X-71WD, for wagon-drill service or the putting down of deep holes. It is said to have a heavier piston and a longer stroke than other machines of this type, thus assuring the rotation and striking power necessary to overcome the inertia of the heavier drill steel utilized. The type permits the use of larger bits. Another feature is the blowing method for which positive action is claimed. The design of the drifter is such that there is little chance for the escape of air around the sides of the shank, thus delivering a strong, steady blast at the bottom of the hole where it is needed for the removal of cuttings.

Packed ready for use in 12-pound tubular containers or 45-pound pails, the Du-Gas Engineering Corporation has put a powder on the market that is said to have advantages over sand for extinguishing incendiary bombs. DuMag, according to that company, remains free-flowing in storage, is nonabrasive and moisture resistant, and does not react with burning magnesium. One tubeful is sufficient to smother a standard 2-pound magnesium-thermite bomb.

Flame-cleaning of structural-steel surfaces for painting is now standard practice with fifteen railroads operating 110,764 miles or 53 per cent of the total United States mileage. The method was recently tried on concrete with satisfactory results. The job involved removing fifteen coats of waterproof and casein paint approximately 1/8 inch thick from the walls of a passenger tunnel at a railway terminal. When everything else failed, the heavy layer was attacked with oxyacetylene torches. According to the report, the casein paint cracked off under the action of the flame, while the waterproof coatings were reduced to a powder that was easily removed by wire brushes, leaving the surface dry and in good condition for repainting.

Flooring that will, it is claimed, prevent the upbuilding of static electricity and stand up under heavy traffic has been put on the market by the Armstrong Cork Company under the name of Conductive Asphalt Tile. The material is intended for use in arsenals, powder plants, and the like, where a spark might prove disastrous.

Appreciable savings in tin are promised through the use of a new lead-base solder containing only 5 per cent of tin. It is a product of Fry's Metal Foundries, Ltd., England, and is said to have a melting point exceeding that of 40-per-cent-tin solder by 122°F. and a tensile strength, when employed to lap-joint steel, of 4,600 pounds per square inch, as against 5,900 pounds.

Lux soap flakes, generally associated with laundering of dainty feminine apparel, are doing their bit in industry. In broaching a hole 3/16 inch in diameter and 2½ inches long in a pressure-pump valve part in mass production, difficulty was experienced in obtaining the desired smoothness of finish. After numerous cutting fluids had been tried with indifferent success, someone hit upon the idea of experimenting with ordinary Lux flakes and water. The result is highly satisfactory, and the solution is now used regularly by the Colonial Broach Company.

Tiny drops of hard glass are replacing imported sapphires in electrical indicating instruments in the United States. They are being produced on a commercial scale and are said to be highly satisfactory.

By substituting pneumatic for certain manual operations, a machine that rolls bags filled with explosive powder into true cylindrical form and wraps them with tape turns out from 30 to 40 per cent more work.

In drawing sheet metal there is less tendency of the die to stick if the metal is protected by cellophane. The latter also serves to prevent wrinkles and scratches. As the cellophane can be used several times, the added cost is nominal.

For loosening tight or frozen engine cylinder-head studs, the Anti-Rust Corporation has prepared a solvent that is applied by means of a transparent-plastic cup with a perforated base and rubber seal. Into the cup, which is screwed on over the stud, is poured a small quantity of the solvent, which works its way between the head and stud and breaks the hold. The solvent, named Rozent, is said to be noninflammable and harmless to the skin. The container, called Rose-cup, is available in two sizes fitting 7/16- and 3/8-inch studs, respectively.

Photo from General Electric Company

CLEANING A TURBINE ROTOR WITH FLY ASH
In overhauling steam turbines, various methods are used for cleaning deposits from the working parts. Some soluble coatings can be removed by washing, while others yield to a jet of water and compressed air. But insoluble deposits such as silica call for a different treatment the most effective of which is sandblasting, except that fly ash is used instead of sand. Fly ash is an extremely fine material derived from the combustion of coal, and the particles are so soft as to be virtually nonabrasive. The fly ash is introduced into the stream of compressed air the same as sand and in like quantities.

n the
shead
with
form-
Con-
se . . .
d and
here's
ns of
2" to
e job

5096

HILA.